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PLAIN, PRAIRIE, AND FOREST.

BY PROF. J. D. WHITNEY.

PART I.

IN spite of all that has been written in regard to the distribution of forests on the North American continent, and the origin of those treeless plains to which the name of prairie is given, the subject is one possessing a great deal of interest, since there is far from being any unanimity of opinion about the various points which are involved in it. The publication of Professor Brewer's map, showing in five degrees of density the distribution of woodland within the territory of the United States, and which is one of the series of charts included in General Walker's Statistical Atlas, seems to offer a convenient occasion and excuse for reverting to the subject of the physical conditions influencing the growth of forests. This has long been a favorite theme with the writer of the present article, and during the twenty years which have elapsed since he has published anything in regard to it, he has had many opportunities of making observations on the distribution of plain, prairie, and forest within the borders of the United States, having crossed the continent several times by various routes lying between Wisconsin and Missouri. In these journeyings he has availed himself of the excellent sections afforded by the various railroad lines crossing the States of Indiana, Illinois, Iowa, and Missouri, accumulating observations which, taken in connection with those previously made during several years of detailed geological work in the heart of the prairie region, enable him to speak from personal knowledge of a wide extent of country, embracing, indeed, a large portion of that area of mingled forests and prairies to a discussion of which this article is to be chiefly devoted.

The use of the word "prairie," which corresponds very nearly with our "meadow," meaning a grassy, treeless, nearly level

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area, dates back to the days of the very earliest explorers of the Mississippi Valley. Father Hennepin describes the prairies along the Illinois River exactly as any other observer would now do. He says, "Elle [the river] est bordée de côteaux [bluffs] dont la pente est couverte de bois et de grands arbres. Quand on est sur ces côteaux, on découvre de belles préries à perte de vûë, garnies d'espace en espace de petits bois, qui semblent avoir été plantez exprès." The distinction between prairie and plain is one which has come gradually into existence as the routes of the emigrant and the explorer have extended themselves farther and farther to the west. Every one knows that the "Prairie States" are those lying contiguous to the Mississippi, on both sides, from Minnesota and Wisconsin down to Arkansas, and that Illinois and Iowa are typical prairie regions. All understand what the phrases "crossing the plains," and "out on the plains," mean; and no Western man would confound the terms prairie and plain. When we reach the Rocky Mountains, and find grassy areas distributed among the ranges, we learn that they are there called "parks" and "holes." This is true, at least, for the central portion of the country, in Colorado and Utah; farther north, in Dakota and Montana, the term prairie is also in use.

For our present purpose it is unnecessary to trace the gradual disappearance of the forests as we proceed west from the well-wooded region of the Appalachian ranges and the Great Lakes. That the distribution of woodland within our territory is in general more influenced by the amount of moisture or the quantity of rain which falls than by any other cause is admitted as a fact beyond dispute. A comparison of the Smithsonian rain-charts with Professor Brewer's map shows this at once. An interesting article might be written on the distribution of the forests over the vast region west of the Rocky Mountains, but with that we have not now to do. It is to the prairie region proper that we propose to devote the present article.

The prairies lie between the forest-covered portion of the country and the plains; hence the idea which seems so firmly fixed in the minds of many, that prairie and plain are the same thing; or, rather, that one is simply passage into the other, the prairie being, so to speak, the incipient plain. It will be necessary, therefore, at first, to show that there is an essential difference between the two kinds of surface, and that their juxtaposition is quite accidental, or certainly depending on other causes than those to which it is commonly attributed.

The prairie is a heavily-grassed area, destitute of forest growth, but existing in the midst of a wooded region, where the climatological conditions are favorable to the growth of timber, but where some other cause than the want of sufficient moisture has operated to prevent this growth. To illustrate how character and distribution of forest and prairie are independent of climatological conditions, let us take the State of Wisconsin, which has an area of about fifty-four thousand square miles, the ninetieth meridian passing nearly through its centre. The northern portion of the State belongs among the most densely wooded regions in the country. This heavily-timbered belt extends from Lake Superior south to the forty-fifth parallel. The sugar-maple is the predominating tree. South of this is a region of pines, not as thickly crowded together as are the trees in the region to the north, but constituting fine forests; still farther south, and occupying the whole area south of the Wisconsin River, is a region of mingled forest and prairie, the trees being chiefly oaks. The cause of this peculiar distribution of the timber in Wisconsin will be noticed farther on; at present it is only desired that the attention of the reader should be called to the entire want of harmony of this arrangement of forest and prairie with the climatological conditions. The Smithsonian charts show a greater amount of precipitation over the prairie area than anywhere else in the State. By no amount of ingenuity can the peculiarities of the isothermal or isohyetal lines be made to play in with the marked differences of the vegetation.

Equally striking are the changes which are met with as one passes from the State of Indiana into the adjacent one of Illinois. The former of these is forest-covered, woodlands extending over probably as much as seven eighths of its area; Illinois, on the other hand, is *par excellence* the prairie State, not more than a quarter or at the most a third of its surface being covered with timber. Here, again, there is nothing to coincide with the distribution either of rain or of temperature; the division seems a purely arbitrary one until looked at in the light of geology. These are only two instances, out of many which might be cited, going to show the absence in certain regions of any essential connection between climate and distribution of forests, and these are sufficient at any rate to indicate the desirability of inquiring what other causes may exist, determining, at least to a considerable extent, the curious intermixture of grassed and timbered areas which we find in the prairie region proper.

The writer has no theory to put forward on the subject; he has simply gone on for years observing the facts, and it is a very brief *résumé* of these facts which it is here proposed to give. But he will first endeavor to dispose of some of the theories of others, declaring that he believes himself to have had better opportunities for observing in the prairie region than any of the writers who of late years have taken up this subject.

There seem to be two prominent theories before the public for their choice in accounting for the existence of the prairies. One of these may be very shortly disposed of, since it is so at variance with all the facts that, as Mr. Foster observes,[1] it is "worthy only of a passing notice." It is to the effect that the prairies exist because the trees have been burned off by the Indians! To use the words of Mr. St. John, formerly State Geologist of Iowa, and one of the most zealous upholders of this theory, "The real cause of the present existence of the prairies is the prevalence of the annual fires. If these had been prevented fifty years ago, Iowa would now be a timbered instead of a prairie State." There seem to be some Western men who are not content unless they can make their country out to be not only the garden but the arboretum of the world. The trees are wanting at present over extensive areas; but they must once have existed, otherwise the Mississippi Valley would be or have been deficient in one of those attributes by which an ideally perfect country is characterized. As the trees do not now exist, they must have been destroyed, and, no other agent being at hand so destructive as fire, that is had recourse to. The prairie grass frequently gets on fire; these fires have burned up the trees! Why the same conditions do not hold good on the present forest-covered States has never been explained. Why the fires have spread themselves only on comparatively level ground, and spared the mounds and the bluffy sides of the rivers, is also a mystery; equally so why they have avoided certain tracts quite surrounded by prairie, like the "groves" of Wisconsin; and, furthermore, why they have paid such respect to the differences of soils and other geological conditions. We have seen large areas of forest burned over, both in New England and on Lake Superior, as well as in the Rocky Mountains, but have no recollection of any of these areas having become prairies in consequence. Once a forest, always a forest, so far as our experience

[1] The Mississippi Valley, page 76. Dr. Newberry says the idea is "simply puerile." (Geology of Ohio. i. 30.)

goes, unless the hand of man comes in to interfere with nature. Mr. N. H. Winchell, although an advocate of the prairie fire theory, seems much impressed with one of the difficulties which it presents, namely, the irregularity with which prairie and forest are intermingled. Speaking of the "Big Woods" of Minnesota, a belt of timber some forty-five miles wide, running from the centre of the State to the northern boundary of Iowa, he says, "The existence of this great spur of timber, shooting so far south from the northern forests, and its successful resistance against the fires that formerly must have raged annually on both sides, is a phenomenon in the natural history of the State that challenges the scrutiny of all observers." We wonder that it had not led him to scrutinize his own theoretical ideas. Of the real cause of the existence of these "Big Woods" we will speak farther on.

By some writers on the theory of the prairies it is held that, as trees can be artificially made to grow upon them, therefore they must originally have been covered by a forest vegetation. This is as if one should argue that because the western part of the State of New York is covered with flourishing wheat fields, and because grain can be raised there with ease, therefore that region must have been always a treeless one!

Let us turn now to the other and by far the most prominent theory advanced to account for the existence of the prairies. It is this: that these treeless plains are in some way a product of the climatological conditions of the country. The only causes connected with climate which we can conceive of as likely to influence the growth of forests are temperature, force of the winds, and moisture; if the latter be the effective agent in determining the position of the wooded regions, then it may be through either excess, deficiency, or irregular distribution of the moisture that the result is attained. In regard to the first of these causes, namely, temperature, we are not aware that this has ever been suggested as having anything to do with the phenomenon in question. There seems to be nothing in the distribution of the isothermal lines in the Mississippi Valley which could be in any way connected with the presence or absence of forests, and certainly nothing connected with the details of the distribution of woodland and prairie could be at all explained by reference to temperature. In regard to the winds, it will be admitted that these do sweep pretty severely over the prairie region, for the reason that it is mostly flat, and therefore unshel-

tered. That the winds on the Pacific coast are, in places, inimical to the growth of forests seems very clear, but this does not seem to be the case in the Mississippi Valley, for we often find the most abundant growth of trees on the very spots which are most exposed to the force of the blast. It is on the rising ground, the knobs, knolls, and mounds which are scattered over the surface of the prairie, that those isolated clumps of timber, called groves, are most likely to be found. If the force of the wind were essentially inimical to the growth of trees, we should find them thriving, if anywhere, in the sheltered nooks, and to the leeward of the northwesters, that being the quarter from which the heaviest blasts come. This is not the case, nor is there anything, so far as we have observed, which would lead to the conclusion that the force or direction of the wind has any sensible effect on the growth or distribution of the timber in the prairie region.

The only climatological cause for the existence of the prairies which is worthy of serious consideration in this connection is the distribution of moisture, and by far the larger number of those who have written on this question have unhesitatingly asserted that in something connected with the rain-fall was to be found the really efficient agent by which the distribution of woodland and prairie has been effected. Exactly what this something is seems, however, not easily to be made out. It must, as it would appear, be one of four things: either the annual rain-fall is on the whole deficient, or it is not favorably distributed through the seasons, or the climate is subject to cycles of drought, or there must be an excess of moisture. In one or other of these categories the influence of the rain-fall must be found, or if not in one single condition of these here enumerated, then in some combination of them.

Let us first examine whether the average annual rain-fall is really deficient, so that the absence of trees over a considerable portion of the Mississippi Valley may be referred to this as a cause. And to settle this question we have no better method than that of comparison between the wooded and prairie regions, taking the Smithsonian rain-charts as a basis for our statements. These charts are, of course, for many districts only rough approximations; for it is, over a large part of the country, only within a few years that statistics have begun to be collected. The data seem, however, to be sufficient for our purpose. If now we examine these charts, we find that for the typical prairie region,

namely, Southern Wisconsin, Illinois, Eastern Iowa, Missouri, and Arkansas, there is no deficiency of rain-fall indicated. Beginning in the densely-wooded region of Northeastern Maine, and following along through the forest-covered districts of Northern New Hampshire and Vermont, New York, the southern part of Upper Canada, the southern part of Michigan, Ohio, Indiana, and so on as far as the Des Moines River, we find spread upon the chart a uniform tint of color, designating an annual rain-fall, over the whole area indicated, of from thirty-two to forty-four inches. This same shade of color extends down and covers almost the whole of the densely-wooded Appalachian ranges in Pennsylvania, Virginia, and North and South Carolina. Looking at the curves which imperfectly divide the region in question, giving a greater amount of detail, we see that not only is the annual precipitation in general quite as great in the prairie region as in most of the ordinarily well-wooded parts of the country, but that when local causes have within certain areas given rise to an excess or deficiency, as compared with the general range of from thirty-two to forty-four inches, there is no corresponding difference in the relative abundance or scarcity of the forests. Thus the upper heavily-timbered part of Michigan shows a decided deficiency of rain-fall, while the only region in that State in which prairies occur over any considerable amount of surface, namely, the southwestern corner, is precisely that where the amount of rain is exceptionally large. Wisconsin, again, shows the same kind of anomaly, for here the prairie region is seen to have the largest amount of precipitation of any portion of the State. Once more: in Iowa, there is a district which is almost entirely covered with forests, namely, the northeastern corner; here, by a curious coincidence, the Smithsonian charts indicate a decided deficiency of rain; while farther west, in a line extending northwest from Iowa City, there is a large area of considerable extent marked as receiving from forty-four to fifty-six inches, and over which, as repeated explorations have convinced us, there is no corresponding increase in the amount of timber. Still more striking facts of the same kind may be had in abundance in Southern Missouri and Northern Arkansas, a region of abundant prairies and of precipitation as great as that of the wettest part of the Atlantic coast. Further statements of this kind do not seem to be necessary to justify the conclusion that in the prairie region there is no deficiency in the annual amount of rain, and that some other cause for the absence

of forests over a considerable portion of the Mississippi Valley must be sought for.

Let us next inquire whether there is anything in the distribution of the rain-fall throughout the year or from season to season which may possibly have a peculiar influence on the vegetation. That this is the case, and that this is, in fact, the predominant cause determining the existence of the prairie, is the theory advocated by Mr. J. W. Foster, at some length, in his work entitled The Mississippi Valley. Mr. Foster thus states his views: "Wherever the moisture is equable and abundant we have the densely-clothed forest, wherever it is unequally distributed we have the grassy plain, and where it is mostly withheld we have the inhospitable desert." That the last of these three dicta is true may be at once admitted. No one will deny that some moisture is necessary to the growth of vegetation, whether it consist of trees, shrubs, or grasses. The other parts of this statement, as we contend, are entirely erroneous. And no better instance can be given of the fact that an equable and abundant distribution of moisture does not always clothe the country with dense forests than that of the vicinity of Chicago itself, where Mr. Foster's book was written. Here we have one of the finest prairie regions in the world, absolutely destitute of trees, and yet in the full enjoyment of an abundant precipitation, and in the immediate vicinity of an immense sheet of water. For Chicago itself, indeed, the statistics of rain-fall are very defective, but such as they are, they are entirely unfavorable to Mr. Foster's hypothesis. Points in the immediate vicinity of that city, where observations have been taken for a series of years, show an annual average rain-fall of from thirty-six to fifty inches, pretty uniformly distributed through the year, as will be seen farther on. An excellent instance, on the other hand, of a dense growth of trees combined with the most unequally distributed rain-fall which is possible is furnished by the western slope of the Sierra Nevada of California, whose magnificent forests are well known, as also is the fact that there is no precipitation there at all for six months of the year, nearly the whole of the rain-fall being limited to three months. And, lest it may be thought that melting snow keeps the ground moist during the summer, it may be added that the heaviest forest belt of the Sierra is quite below the line above which snow rests for any considerable time, and that the soil in that belt is usually perfectly dry at the surface, and even dusty, for six months of the year, and often much more.

From other parts of Mr. Foster's chapters on the origin of prairies, in his work already cited, it would appear, however, that he considers the deficiency of rain in the winter months to be the essential cause of the absence of forests. He remarks as follows:[1] "A region where the annual precipitation is slightly in excess of twenty inches, I infer from observation, is unfavorable to the growth of trees, even were this moisture equally distributed, but where three fourths of it is precipitated during the spring and summer, the grasses flourish and mature to the exclusion of arborescent forms." This seems also to be the theory advocated by Dr. Newberry, from whom we quote as follows:[2] "Those who know anything of the climate of the prairie belt know that it is characterized by a *deficiency* of *winter rain* and snow, and by occasional though rare seasons of excessive dryness. The want of winter rains to deeply saturate the ground gives to the superficial hibernating grasses, which may be said to live upon the almost copious summer rains, an advantage over trees equal to a victory."

Let us now examine this question in the light of the Smithsonian rain-tables and Mr. Schott's discussion of them. This very point is taken up, under the head of Annual Fluctuation in the Rain-Fall, annual fluctuation, as Mr. Schott explains it, meaning the "changes from month to month." He gives the typical curve for the "region embraced in the Hudson River Valley, Vermont, and Northern and Western New York," as derived from an aggregate of five hundred and sixty-four years of observation. He also gives from the records of one hundred and fourteen years the curve for "the Upper Mississippi from Fort Madison, Southern Iowa, to Fort Ripley, Central Minnesota, and including part of Wisconsin." One of these regions, as will be readily seen, is a region of forests, the other of prairies. It would be difficult to select two districts in this country of equal area more characteristically situated for showing the difference between the rain-fall of a wooded and of a prairie country. Yet we find Mr. Schott declaring that the two curves thus obtained, and representing typically the distribution of the rain-fall throughout the year, "do not materially differ." In each case there are two maxima, one about the beginning of the summer and the other at its end, and also a principal minimum about the beginning of February. The only difference between the two types

[1] Mississippi Valley, page 101.
[2] Geology of Ohio, i. 30.

is that in the one case one of the maxima falls in September and in the other in October, and that the range is a little larger in the more westerly region. We find, on examination of the tables, that from about forty to forty-five per cent. of the total precipitation of the prairie region comes in the autumn and winter months, and that these conditions do not materially differ from those prevailing in some of the most densely-wooded portions of the country. To illustrate these points we append a table showing the amount of precipitation at some of those places in the prairie region where observations have been longest kept up, with additional figures from some portions of the densely-timbered country.

	Precipitation, in Inches.				Total, in Inches.
	Spring.	Summer.	Autumn.	Winter.	
Peoria, Ill	10.00	10.34	8.46	7.03	35.83
Ottawa, Ill	9.89	11.25	8.68	7.37	37.19
Manchester, Ill	11.49	8.71	8.76	8.83	37.79
Athens, Ill	11.55	12.04	8.55	7.48	39.62
Pekin, Ill	10.44	12.50	9.45	8.86	41.25
Winnebago, Ill	9.72	12.31	9.66	6.14	37.83
Platteville, Wis	9.88	13.63	9.32	6.48	39.31
Dubuque, Iowa	7.10	10.53	9.38	5.23	32.24
Muscatine, Iowa	11.92	13.79	10.35	6.82	42.88
Iowa City, Iowa	11.27	13.04	13.11	5.70	43.12
Clinton, Iowa	11.40	13.94	10.40	7.98	43.72
Davenport, Iowa	10.70	13.71	8.56	6.49	39.46
St. Louis, Mo	12.42	13.04	9.07	7.65	42.18
Ontonagon, Mich	5.43	7.44	6.48	6.44	25.79
Marquette, Mich	6.49	9.02	8.11	6.39	30.01
Fort Brady, Mich	5.06	9.59	10.68	4.99	30.32
Detroit, Mich	8.51	9.29	7.41	4.82	30.03

The last four places are situated in thickly wooded regions, the others are on or near the prairies, and they include nearly all the localities in Illinois and Iowa where observations have been kept up for as much as ten years. Attention is called to the small annual amount of rain in the densely-timbered districts bordering on Lake Superior and Lake Huron, and also to the fact that there the statistics of its distribution through the seasons are much more unfavorable to the growth of forests, according to Mr. Foster's theory, than anywhere on the prairies.

In view of the above figures it may be unhesitatingly affirmed that there is no basis for the theory that an unequal distribution of rain throughout the year brings about a treeless condition of the surface. It is surprising that those who maintain that a deficiency of winter rain prevents the growth of trees should not

have recollected that over a large part of the forest region of the north and northeast there is, practically speaking, no precipitation at all in the winter, since the snow which then falls, to the exclusion of rain, accumulates on the frozen surface and does not begin to wet the ground until spring, when it, to all intents and purposes, by its melting adds so much to the spring precipitation, thus bringing the total effect exactly to a par with that which is claimed by Dr. Newberry as being fatal to the existence of forests.

When we come to examine into the conditions of the climate in Southern Missouri and Arkansas, which are also regions of extensive prairies, we find that there is still less reason for advocating a deficiency of moisture as the cause of the treeless condition of the surface than there is farther north in the States for which statistics have been given. The tables of the rain-fall are very deficient for the region west of the Mississippi and south of the Missouri. Arkansas, however, is put down on the Smithsonian charts as lying chiefly within the belt of forty-four to fifty-six inches of precipitation. There are only two stations where observations have been kept up for any length of time; these are Washington, in longitude 93° 41′ and latitude 33° 44′, and Fort Smith, on the extreme western border of the State. At these places a precipitation of 54.50 and 40.36 inches is indicated. Short series at Helena and in Union County give respectively 81.08 and 74.63 inches. Helena, with this enormous precipitation, is the nearest station to Prairie County, of which the surface is "mostly open prairie."[1] An examination of the Smithsonian charts will show that Southern Missouri is also a region of large precipitation. Here there is considerable prairie, some of it in the river bottoms. The region is a rough and broken one, and the conditions of soil and surface quite complicated with respect to distribution and character of timber. There is a considerable area covered with a scattered growth of oaks, locally known as "oak barrens." These, however, do not depend for their existence on any scarcity of moisture.

As there is no proof whatever that an occasional year of drought in the prairie region would be a sufficient cause for the absence of timber, and as there is, furthermore, no proof that this region is peculiarly liable to droughts, it is hardly necessary to take this matter into serious consideration. It would be easy to point out regions on the Pacific coast and elsewhere in which

[1] D. D. Owen, First Arkansas Report, page 242.

the distribution of the rain from year to year is very capricious, but where, none the less, the forests are well maintained. Mr. Schott's investigations give us no authority for saying that the prairie region is more liable to droughts than the region of forest immediately adjacent to it.[1]

That an excess of moisture is in general prejudicial to tree-growth must of necessity be admitted. This fact seems to form the basis of the views of Mr. Lesquereux in regard to the origin of prairies. And to a considerable extent there is a harmony of opinion between us; indeed, the writer finds that this gentleman is the only one of those who have written on the prairies who has carefully observed the leading facts. Before, however, noticing his views, it will be well that the author of this article should state exactly to what results his own observations have led him, and what seems to him the all-important consideration influencing the character of the vegetation in the prairie region.

(To be concluded in the next number.)

CARNIVOROUS PLANTS.

BY PROF. W. J. BEAL.

THIS is a new term which has lately been applied to plants that catch insects by various contrivances.

In 1768, over one hundred years ago, Mr. Ellis discovered that the Venus fly-trap, of North Carolina, catches insects by a peculiar construction of the tips of its leaves, like a steel-trap. Numerous experiments have satisfied botanists that flies are not only caught, but digested by a fluid poured out by the plant, and the materials absorbed into the tissues of the plant. In 1780, ninety-five years ago, the sun-dew (*Drosera*) was found to catch insects by its sensitive hairs with a sticky gland at the end of each.

Drosera rotundifolia, a common little plant of our marshes, has a round leaf, about the size of a cent, sometimes containing

[1] See page 158 of Mr. Schott's paper. He says, "The observed succession of annual amounts of rain-fall on the Atlantic coast from Maine to Virginia, and in the interior of the State of New York, seems to be governed by the same circumstances or laws, as is evident by a comparison of the curves of Type I. [Maine to Virginia] and Type II. [State of New York], and indeed Type III., region of the Upper Mississippi (Iowa), bears some resemblance to these curves, but is not yet sufficiently developed to be pronounced identical in character. . . . . The remarkable period of droughts about 1836, as well as the less conspicuous or relative one of 1855, are common to the two regions [Type I., State of New York, and Type IV., region of Upper Mississippi, Iowa]."

eighteen small flies. The glandular hairs move toward the fly when irritated.

Drosera longifolia has a very long, slender leaf, also covered with glandular hairs. It rapidly coils up from the tip, catching flies, which it devours and absorbs.

North America has eight species of pitcher plants (*Sarraceniaceæ*) the leaves of which catch insects. They have stiff hairs inside, pointing downward, which prevent the escape of most insects. Some have a sweet secretion below the opening at the top on the outside. This grows sweeter and sweeter and more abundant, till it comes to the opening, to entice foolish flies to the fatal pit whence no fly ever returns.

Catesby, some years ago, thought these pitchers were an asylum for insects to escape from frogs and other animals. I have here some fresh specimens of *Sarracenia purpurea*, the only pitcher plant found in Michigan. Pouchet, in his popular book, The Universe, speaking of this plant, says, "The leaves rise from spot to spot at the feet of the traveler, and are filled with pure and delicious water, for the benefit of which he is all the more grateful that he is encircled by nothing but marshes." The truth is, the water abounds in rotten bugs and worms.

Of *Nepenthes* there are some thirty species, most of which secrete honey on some parts of their pitchers, to entice insects, which they catch and devour.

The spathe of *Alocasia*, it is said, catches slugs and destroys them in a strong secretion. For a full account of the above interesting plants, see Dr. Hooker's Inaugural Address, last year, at the British Association, printed in *Nature*, x. 366.

Pinguicula catches insects.

According to Mrs. Treat, bladderworts (*Utricularia*) catch infusoria and other small animals. These are taken by strange devices in the little bladders, which work like some miniature eel trap. The animals are dissolved and contents absorbed by the plant. In addition to the above, we have quite a large number of other plants belonging to divers natural orders, which catch insects. The young leaves and stems of *Rhododendron* is one of them. A species of *Plumbago* in the green-house, sent from the Agricultural Department at Washington, has viscid hairs about the flowers, large enough to catch and hold a common house-fly, even if caught by one or two legs. Several species of *Polanisia*, *Cupœa viscosa*, some species of *Physalis*, and *Solanum*, catch small insects by sticky hairs on the younger portions of the plant.

Many species of *Silene* attract, catch, and hold insects to such an extent that the genus goes by the popular name of "catch-fly."

Lychnis vespertina, a kind of cockle sometimes in our wheat fields, also takes small insects. It seems to digest them by the small glands at the end of the hairs. We need not necessarily suppose that they are digested because they are captured by sticky plants.

The large bud scales of the horse-chestnut and balsam poplar, in the spring of the year, are often found holding insects by the sticky varnish with which the buds are very copiously covered. We see that the varnish may be of use to protect the inner delicate parts of the bud from the inclement weather, but I am unable to see that insects are of any advantage to the plant when so caught. The dry bud scales are sticky for a purpose which we can readily understand. The flies are most likely accidentally caught. Possibly this is the case with some other plants which catch insects by a sticky secretion or other contrivance. I have lately given some attention to the *Martynia* on account of the great numbers of small insects which it catches by glandular hairs. On August 3d I counted seventy-six small Diptera and some other insects on the upper side of a young leaf of about four inches average diameter, and two hundred on the under side. The insects are caught on all parts of the plant which are exposed, on the stems, on the calyx and corolla, including even the throat of the corolla. Among a lot of others was one plant about three feet high, spreading three feet in diameter, which according to estimate had seven thousand two hundred small flies on it at one time. The hairs are very numerous all over the surface. None of them are sensitive, as I can find. They vary exceedingly in length, from three sixteenths of an inch to one one-hundredth or even shorter. Some of them have as many as ten cross partitions. The contents of these cells appear quite clear, except one near the top, next to the top cell. This is larger than several of those below, and contains chlorophyll. It seems to be something like a gland. Above this is a larger cell, with perpendicular striæa along its sides. When fresh and undisturbed the top is nearly spherical and resembles a small drop of dew. The secretion is quite copious and exceedingly viscid, with an unpleasant odor. I placed some small fragments of raw beef on the glands one morning, but the sun seemed to dry them up, much as it did those left on blades of grass which had no glands. I placed some very minute portions on the glands in a spot shel-

tered from the direct rays of the sun. In some cases the whole of the piece of beef disappeared.

The small insects seem to live but a short time, although they are touched by only two to four hairs. The substance seems to be soon taken out of the insects. In my opinion, it is a true insectivorous plant. (Proceedings Amer. Assoc. Adv. Sc., 1875.)

A CENTURY'S PROGRESS IN AMERICAN ZOÖLOGY.

BY A. S. PACKARD, JR.

THE title of this article is almost a misnomer, since American zoölogical science dates only from 1796, when Barton published his Memoir on the Fascination attributed to the Rattlesnake, while his Facts, Observations, and Conjectures on the Generation of the Opossum appeared in 1801. These were simply memoirs, but still talented productions and not unworthy to begin the century. Previous to this, John Bartram published a few zoölogical tracts in the Philosophical Transactions of the Royal Society of London, the first appearing in 1744, while his Description of East Florida, etc., was published in London in 1769.

John Bartram was born in this country, and so was Barton; but the latter was, perhaps, the more genuine biologist, and his work was so well appreciated in England that he was called by Swainson the "father of natural history in America." The first century of American zoölogy should, then, date from 1796, and it had a worthy beginning.

American systematic zoölogy may be said to date from the years 1808–14, when the successive volumes of Wilson's Ornithology were published, though it should be remembered that Wilson was born and bred in Scotland. Thus, with the exception of Bartram's and Barton's works, what we have to say of American zoölogy (including animal physiology and psychology and embryology) covers only a little over half a century.

The next work was by Prince Bonaparte, on birds, a volume complementary to Wilson's great work, and published in this country in 1825–33.

But the first general work by a native-born American was Dr. Richard Harlan's Fauna Americana, published in 1825. This was succeeded by Dr. John D. Godman's work on North American Mammals, published in three volumes in 1826–28. Bartram,[1]

[1] John Bartram was born at Darby, in the suburbs of Philadelphia.

Barton, and Harlan were born in Philadelphia and taught anatomy there. Godman was born in Annapolis, and lectured on anatomy in three medical colleges, but not in Philadelphia. On the whole, American zoölogy took its rise and was fostered chiefly in Philadelphia by the professors in the medical schools; and zoölogy the world over may be said to have sprung from the study of human anatomy, as taught at the anatomical centres of Italy, France, England, and Germany.

The last half-century of progress in zoölogy in America may be divided into three epochs: —

(1.) The epoch of Systematic Zoölogy, during which a few physiological essays appeared. To this department of zoölogy a most decided impulse was given by the Smithsonian Institution, which went into active operation in 1847, while the study of the fossil forms (palæontology) was greatly accelerated by the influence of national and especially state surveys.

(2.) The epoch of Morphological and Embryological Zoölogy. This period is due to the arrival of Louis Agassiz in this country, in 1846, resulting in his lectures on comparative embryology and the foundation of the Museum of Comparative Zoölogy, where American students, who were attracted by the fame of Agassiz, were instructed in the methods of Cuvier, Von Baer, Döllinger, and Agassiz himself, and zoölogy was studied from the side of histology and embryology, while palæontology was wedded to the study of living animals.

(3.) The epoch of Evolution, or the study of the genetic relationship of animals, based on their mutual relations and their physical environment. This period dates from the publication of Darwin's Origin of Species, in 1859.

Turning, now, to the first epoch, — that in which American systematic zoölogy took its rise, — we find that work was done which must necessarily precede more important studies on the embryology, geographical distribution, mutual relations, and psychology of animals, and which exerts a marked influence on the classification of animals, which nowadays is equivalent to tracing their genetic relationships; for the time is past when the animal world should be regarded as comprised within separate sub-kingdoms, between which there is no morphological or genetic connection.

The systematic works are so well known and our space so limited that we shall merely enumerate the names of our chief zoölogical authors. In the study of mammals the works of Audubon and his predecessors, already named, and of Thomas Jef-

ferson, T. Say, J. Bachmann, G. Ord, S. F. Baird, T. Gill, Harrison Allen, J. A. Allen, E. D. Cope, Elliott Coues, J. Y. Scammon, B. G. Wilder, and W. S. Barnard, should be mentioned, with the palæontological essays of R. Harlan, J. C. Warren, J. Leidy, Cope, and O. C. Marsh, together with Godman's Rambles of a Naturalist and L. H. Morgan's work on the beaver, and physiological essays by J. Wyman, S. Weir Mitchell, J. C. Dalton, and others.

The ornithological works of Wilson, Bonaparte, Audubon, Nuttall, Baird, Cassin, and Coues, the more recent great work of Baird, Brewer, and Ridgway, Coues's Birds of the Northwest, and the many descriptive and biological papers of other authors, such as T. M. Brewer, Ord, J. P. Giraud, J. K. Townsend, A. L. Heerman, G. N. Lawrence, H. W. Gambel, J. Xanthus, H. W. Henshaw, H. Bryant, S. Cabot, T. M. Trippe, C. J. Maynard, and others, with the papers on distribution by Baird, A. E. Verrill, Allen, and R. Ridgway, together with those on fossil birds by Marsh and Cope, are all worthy of comparison with the best European works and papers.

The reptiles and amphibians have been described by Harlan J. E. Holbrook, T. Say, J. Green, Baird, C. Girard, E. Hallowell, L. R. Gibbes, C. A. Lesueur, J. E. LeConte, L. Agassiz, and Cope, and an entire assemblage of forms in the western Cretaceous and Tertiary formations has been discovered by Leidy, Marsh, and Cope. The anatomy of the nervous system of *Rana pipiens*, by Jeffries Wyman, is a classic, as are the researches of S. Weir Mitchell upon the Venom of the Rattlesnake and the Researches on the Anatomy and Physiology of Respiration in the Chelonia by S. Weir Mitchell and G. R. Morehouse.

The fishes of North America have been worked up by S. L. Mitchell, Lesueur, C. S. Rafinesque, D. H. Storer, J. E. Dekay, Holbrook, Agassiz, Girard, J. P. Kirtland, J. C. Brevoort, Wyman, Baird, Gill, Cope, W. O. Ayres, F. W. Putnam, T. G. Tellkampf, D. S. Jordan, H. C. Yarrow, C. C. Abbott, G. B. Goode, R. Bliss, S. W. Garman, and others; while the fossil forms have been described by J. H. and W. C. Redfield, Leidy, R. W. Gibbes, J. S. Newberry, Cope, and O. St. John.

In entomology the writings of Say, the two LeContes, F. E. Melsheimer, N. Hentz, T. W. Harris, S. S. Haldeman, R. von Osten Sacken, B. Clemens, J. D. Dana, G. Horn, S. H. Scudder, P. R. Uhler, H. Hagen, B. D. Walsh, A. S. Packard, Jr.,

A. R. Grote, W. H. Edwards, Henry Edwards, Sumichrast, H. C. Wood, A. Fitch, C. V. Riley, E. Norton, J. H. Emerton, C. Thomas, B. P. Mann, and others, are in most cases quite voluminous, though mostly descriptive, while the fossil forms have been described by Dana, Scudder, Meek and Worthen, S. I. Smith, and O. Harger. Their anatomy has been studied by Leidy, Scudder, and Packard.

The great work of Dana on the Crustacea of the United States Exploring Expedition placed him next to Milne-Edwards at the head of living authors in this department, and his essay on their geographical distribution is the starting-point for all such inquiries. In this connection should be noticed the essays of Dana on cephalization in animals, suggested in the first place by his studies on the Crustacea. The North American species have been described by Say, W. Stimpson, J. W. Randall, L. R. Gibbes, S. I. Smith, Hagen, Packard, and O. Harger, and the fossil forms by Green, Hall, Billings, Stimpson, and others.

The intestinal and higher worms have been worked up by D. Weinland, Girard, Leidy, Wyman, Stimpson, and Verrill; and of the aberrant classes, the Polyzoa have been carefully studied anatomically by A. Hyatt, the Brachiopoda by E. S. Morse and W. H. Dall, and several species of Tunicata described by C. A. Lesueur, Tellkampf, Louis and A. Agassiz, Verrill, and Packard; while their development has been studied by Morse.

The Molluscs of North America have been elaborated by Say, Gould, Lesueur, Rafinesque, Haldeman, I. Lea, T. A. Conrad, C. B. Adams, Stimpson, the two Binneys, J. W. Mighels, J. P. Couthouy, E. Ingersoll, A. Agassiz, T. Bland, T. Prime, Morse, J. Lewis, Dall, Tryon, Verrill, R. E. C. Stearns, Sanderson Smith, and others. The fossil Mollusca of entire formations have been described by Hall, Billings (of Canada), F. B. Meek, C. A. White, F. S. Holmes, O. St. John, C. F. Hartt, R. Rathbun, O. A. Derby, Whitfield, N. S. Shaler, Whiteaves (of Canada), and other palæontologists, and the quaternary species studied by Holmes, Dawson, Stimpson, Packard, Verrill, Matthews, and others. Their anatomy has been studied by Leidy, Wyman, Morse, Dall, and W. K. Brooks.

The Radiates (including the Cœlenterates and Echinoderms) have been carefully elaborated by Louis and A. Agassiz, and by Say, Stimpson, E. Desor, Ayres, Macrady, H. J. Clark, T. Lyman, and Verrill; while Dana's elaborate report on the Zoöphytes of the United States Exploring Expedition took the

nighest rank among systematic works. Numerous fossil forms have been brought to light by Hall, Billings, Meek, Shumard, White, Whitfield, W. H. Niles, O. A. Derby, and other palæontologists, and the distribution of the recent forms on both sides of the continent has been studied by Verrill and A. Agassiz.

The Sponges have been chiefly studied by Clark and Hyatt; and the Protozoa by J. W. Bailey, Clark, Leidy, and Tuttle.

We may congratulate ourselves on the high position of our palæontologists in the scientific world. The labors of James Hall, Meek, Billings, Dawson (of Montreal; we have included Canadian students in this article), and others have revealed whole platforms of life in the Palæozoic rocks; while the researches of Leidy, Marsh, and Cope in the Tertiary and Cretaceous beds of New Jersey and the West, and of Deane, Hitchcock, Leidy, Wyman, Newberry, Emmons, and Cope in Triassic and Carboniferous strata, have been productive of valuable results.

The discovery of the fossil bird-like reptiles of New Jersey, by Leidy and Cope; of birds with teeth and pterodactyls without teeth; of lemur-like monkeys, by Marsh; and the discovery by Leidy, Marsh, and Cope of connecting links between living ruminants and hog-like forms, and between elephants and tapirs; together with the genealogy of the horse, and the increase in the size of the brain of living forms over their Tertiary ancestors, as elaborated by Marsh, all present a mass of new facts bearing on the evolution of life on the American continent and the general doctrine of evolution.

In philosophical zoölogy Dana's papers on Cephalization, and Wyman's views on the Vertebrate Theory of the Skull, in his memoir on *Rana pipiens*, and his studies on antero-posterior symmetry in vertebrates; those of James Hall on the succession of molluscan life in palæozoic rocks; and those of Agassiz on prophetic and synthetic types, and laws of embryological growth as correlated with the succession of extinct forms, with other views in his Essay on Classification, should be here cited. The deep-sea researches of L. F. de Pourtales on the coast of Florida enabled him to state that "animal life exists at great depths in as great a diversity and as great an abundance as in shallow water." This was in 1867, before the cruise of the English steamer Porcupine and the researches of Carpenter, Thompson, and Jeffreys.

The epoch of embryology or the developmental study of animals was inaugurated by Agassiz in 1846. In the publica-

tion of his Contributions to the Natural History of the United States, mainly devoted to the developmental history of the radiates and turtles, Agassiz was assisted by H. J. Clark, who, under his training, became the best histologist our country has yet produced. W. J. Burnett, another histologist, was only inferior to Clark. Macrady, another of Agassiz's students, published some papers of importance on the Acalephs and their mode of development. Desor and Girard wrote on the embryology of worms. Memoirs of a high order of merit followed, from the pen and pencil of Mr. Alexander Agassiz. His embryology of the Echinoderms appeared between 1864 and 1874; the memoir on the Alternation of Generations of the worm, *Autolycus*, appeared in 1862; his paper on the early stages of Annelids in 1866; his remarkable memoir on the transformation of *Tornaria* into *Balanoglossus* was published in 1873; and his elaborate embryology of the Ctenophores in 1874. In 1864, Jeffries Wyman, at the time of his death our leading American comparative anatomist and physiologist, published a memoir on the development of the skate. The beautiful memoir of Hyatt on the embryology of Ammonites was a difficult research, while the brilliant papers of Morse on the early stages of the Brachiopod, *Terebratulina*, published in 1869–73, enabled him, by embryological as well as anatomical evidence, to transfer the Brachiopods from the Mollusca to the vicinity of the Annelidan worms. His studies on the carpus and tarsus of embryo birds should also be mentioned. In 1872 Packard published a memoir on the development of Limulus, and pointed out the affinities of its young to certain young Trilobites; and he also published papers on the embryology of the Thysanourous, Neuropterous, Coleopterous, and Hymenopterous insects. S. I. Smith traced the metamorphoses of certain crabs and shrimps. Several entomologists, as Harris, L. Agassiz, Fitch, Riley, Scudder, Packard, LeBaron, Hagen, Cabot, Walsh, Saunders, Edwards, and others, have studied the metamorphoses of insects, while the drawings in illustration of Abbot and Smith's Natural History of the Rarer Insects of Georgia were made by Abbot, who lived several years in Georgia. In 1874 Emerton described the embryology of the spider, *Pholcus*, and during the present year an important memoir by W. K. Brooks on the anomalous mode of development of *Salpa*, a Tunicate, has appeared. We may, then, take an honest pride in the embryological work done by American students; for in this department great activity was shown when scarcely anything was being done in En-

gland or France, and the United States have been for twenty-five years past only second in embryological studies to Germany, the mother of developmental zoölogy.

Of anthropological authors, we have room only to speak of Morton, Davis, E. G. Squier, Pickering, L. H. Morgan, Agassiz, Nott and Gliddon, Wyman, J. D. Whitney, Foster, Jones, Abbott, Berendt, Leidy, Baird, Dall, Putnam, C. A. White, Rau, Gillman, Meigs, Jackson, Barber, and a number of men now in the field, chiefly of aboriginal archæology.

The third or evolutional epoch produced an original and distinctively American school of evolutionists. Hyatt's memoir On the Parallelism between the Different Stages of Life in the Individual and those in the Entire Group of the Molluscous Order, Tetrabranchiata, was published in 1867, and several papers extending his views to other groups of Ammonites and Mollusks have appeared since then. Cope's Origin of Genera was published in 1868, and his paper On the Method of Creation of Organic Types, in 1871. Hyatt's views essentially agreed with those published by Cope, but were less general in their application. The theories of both authors are based mainly on the embryological and post-embryonic changes of animals, and on the idea that the different degrees of acceleration and retardation of the growth of the individual are paralleled by those of genera, families, orders, and classes. This hypothesis attempts to account for the origin of the different groups of animals, and, we believe, will lead to a more general and fundamental doctrine than natural selection. As Cope observes, the law of natural selection "has been epitomized by Spencer as the 'survival of the fittest.' This neat expression, no doubt, covers the case; but it leaves the origin of the fittest entirely untouched," and he accordingly seeks for the causes of the origin of the fittest. Here also should be mentioned the writings of Baird, Allen, and Ridgway on the laws of geographical distribution and climatic variation in mammals and birds, which have revolutionized our nomenclature in these classes, and bear directly on the evolution hypothesis. Special attempts to ascertain the probable ancestry of living American mammals have been made by Gill, Cope, and Marsh; of cephalopod mollusks, by Hyatt; of insects, by Packard; and of brachiopod worms, by Morse.

Contributions to the doctrine of natural selection have been made by Dr. W. C. Wells, Rafinesque, Haldeman, Walsh, Riley, Morse, Brooks, and others.

Such has been the progress of zoölogy in the United States within less than a century. Its future progress will in part depend on the attention paid to it by medical students, to whom we may look for treatises on histology and embryology. At present there are no histologists in the United States who have published special monographs. When professorships of zoölogy alone are established in our colleges (at present mineralogy, botany, zoölogy, and geology are often taught by a single person) competent science-teachers will arise for our higher schools, and the science, we may hope, will be cultivated with something of the thoroughness of the German methods. At present we are not so greatly behind France and England as we were twenty years ago. There is, however, danger that Russia will outstrip us, and we are about on a level with the Scandinavians and the Dutch.

With our energy and native ability, and the aid of well-endowed colleges and museums, we may hope hereafter to compete even with Germany. The development of any branch of science is largely dependent on individual students, and every opportunity should be afforded young men of promise of devoting their time to original research. Specialists are sadly wanted in a country like ours, where the tendency is, perhaps, rather to the production of mediocrity than of genius.

THE MISSING LINK BETWEEN THE VERTEBRATES AND INVERTEBRATES.[1]

THE views which Dr. Dohrn has recently put forth, as to the details of the steps by which the vertebrate stock arose out of an ancestry not very much unlike the existing Annelids, are of such interest that, notwithstanding previous reference to the subject, no apology is needed for presenting the readers of *Nature* with a condensation of the main argument contained in The Origin of Vertebrata.

Dr. Dohrn first draws attention to the correspondences between vertebrate and insect embryos, which have been too little regarded in consequence of our designating the nervous side in the one as dorsal, in the other as ventral. Yet the facts that, in both, the nervous system is developed on the convex side of the embryo and acquires a strong convex flexure anteriorly, and that

[1] Der Ursprung der Wirbelthiere und das Princip des Functionwechsels: Genealogische Skizzen. Von Anton Dohrn. (Leipzig: Engelmann.)

the body-cavity is finally closed up on the side of the body opposite to the nervous system, point to a common origin at a comparatively high level. The surface of the animal which is called ventral is determined by the presence of the mouth on that surface; and if any vertebrates had a mouth-opening between the brain and the spinal cord on the dorsal surface, that dorsal surface would necessarily become ventral. Since, moreover, the ancestors of the vertebrata must have had a nervous ring surrounding their gullet, it would appear more reasonable to suppose that the mouth-opening had been changed in the course of development than that the situation of the nervous centres had been altered. We are thus led to look for traces of an old mouth-opening on that surface of the early vertebrates which corresponded to our dorsal surface, and to seek reasons for regarding our present mouth as a comparatively modern development.

Dr. Dohrn believes that the old mouth passed through the nervous centres between the crura cerebelli, or, more accurately, in the fossa rhomboidea, or fourth ventricle, which is remarkable for being of greater proportionate size early in development, and afterwards undergoing retrogression. At an early stage we only need to conceive a slit to be made in the nerve tube at the bottom of the fossa rhomboidea, in order to furnish a suitable passage into the alimentary canal. His first reason for regarding the vertebrate mouth as a modern structure is that it arises so extraordinarily late in development. The embryonic body is almost completely framed, all the great systems are established, the circulation is in active operation, while as yet there is no mouth. Again, the mouth does not arise in the position in which it permanently remains in the great majority. It undergoes considerable shifting forwards. Only in the Selachians and Ganoids does it retain its primitive situation. Moreover, the study of development is steadily tending to establish the idea that the mouth of vertebrates is homodynamous with the gill-clefts. It is limited, like them, by a pair of arches, lies just in front of the first pair of gill-clefts, arises simultaneously with them in the embryo, and opens into the alimentary canal. A glance at the ventral surface of a Ray shows the likeness of the mouth to a pair of coalesced gill-clefts. Consequently, it becomes probable that the present mouth-opening once existed and functioned as a gill-cleft; that at a certain period in the ascending development, both the old and the new mouths supplied nourish-

ment, that the latter gained the predominance, and that finally the old mouth became aborted.

The next problem attacked is the origin of the gill-clefts. A very elaborate account is given of the supposed process by which the external gills and segmental organs of Annelids were metamorphosed into the gills and gill-clefts of vertebrates and the skeletal elements connected with them. The great difficulty which Dr. Dohrn confesses in this matter is the connection of the inner extremities of the segmental organs with the wall of the alimentary canal. But if this be granted it is comparatively easy to understand how the shortening and widening of the segmental organs might give rise to gill-cavities such as those of the Selachians. The process by which Dr. Dohrn conceives that the limbs of vertebrata might have been developed from two pairs of gills in Annelids is a greater evidence of ingenuity, though it is to be expected that it will be viewed rather incredulously.

It follows from the view of the origin of vertebrates thus expounded that Amphioxus loses much of its interest, for there is no place for Amphioxus among Annelids, nor among the primordial vertebrates; it lacks almost all that they possess. Yet nothing can be gained by excluding Amphioxus from the vertebrates; for it is so connected with the cyclostome fishes that it cannot be placed at any great distance from them; while on the other hand it is so related to Ascidians that the latter must be included among the vertebrata.

Dr. Dohrn then proceeds with a long argument to show that the cyclostome fishes are degenerate from a higher type of fishes, and that Amphioxus is a result of still further degeneration. He shows how their mode of life necessitates many of the modifications they have undergone, and that the diversities of the details of structure in cyclostomes are inconsistent with their being viewed as representing stages in upward development. Finally, the larva of Ascidians is represented as a degenerate fish — a degenerate cyclostome, possibly — which carries to the extreme all the departures of the latter from the fish-type. The most important element in this degeneration results from the fact that Ascidians, instead of being attached to fishes or to any objects from which they can derive nutriment, are fixed to stones, plants, etc., or to such parts of animals (cephalo-thorax of crabs, tubes of tubicolous annelids) as do not afford them nourishment. Consequently they have lost the old mouth in the organ of attachment, homologous with that of all vertebrates, and have developed a

new one, homologous with the nasal passage of *Myxine*. Thus we can explain the astonishing fact that the mouth-opening of the Ascidian larva has a communication with the fore-wall of the so-called cerebral vesicle. It is the last vestige of the openings in the nasal sacs by which the olfactory nerves entered.

The most patent objection to Dr. Dohrn's view about Amphioxus is that it fails to account for the development of a many-segmented respiratory apparatus as a degeneration from a higher animal with a small number of gill-arches. It would appear far more reasonable to suppose Amphioxus to be a degeneration from a much lower elevation than the cyclostome type, namely, from some stage where the respiratory apparatus retained the multiserial character derived from its Annelid forefathers.

The key-note of the author's reasonings is to be found in the principle of transformation of function (*Functionswechsel*), on which he lays great stress. He states it as follows: The transformation of an organ happens through a succession of functions being discharged by one and the same organ. Each function is a resultant of several components, of which one constitutes the chief or primary function, while the others are lower or secondary functions. Diminution of the importance of the chief function with increase of the importance of a secondary function alters the entire resultant function; the secondary gradually rises to be the chief function, the resultant function becomes different, and the consequence of the whole process is the transformation of the organ. This principle is considered to be a complete answer to the difficulty so strongly insisted on by Mr. Mivart, the incompetency of natural selection to account for the incipient stages of subsequently useful structures. Dr. Dohrn's statement of his principle does not strike us as very different from Mr. Darwin's (Origin of Species, fifth edition, page 251), though a little more definitely stated. Mr. Darwin says, "The same organ having performed simultaneously very different functions, and then having been in part or in whole specialized for one function; and two distinct organs having performed at the same time the same function, the one having been perfected whilst aided by the other, must often have largely facilitated transitions." The illustrations given by Dr. Dohrn of the steps by which the anterior extremities of crustacea became applied to mastication, how the mouth of vertebrates originated from a pair of gill-clefts, how the respiratory apparatus of tunicates originated from that of vertebrates, etc., are, however, exceedingly interesting.

An English translation of Dr. Dohrn's pamphlet could not fail to be serviceable to the large number of students who take an interest in the genealogical problems of morphology. — G. T. BETTANY, in *Nature*.

A COSMOPOLITAN BUTTERFLY. II. ITS HISTORY.

BY SAMUEL H. SCUDDER.

NOTWITHSTANDING the ubiquity and general abundance of *Vanessa cardui*, its natural history is imperfectly known. Of its life in the tropics there is no published statement beyond the brief account given by the indefatigable Horsfield; he simply mentions that in Java the caterpillar feeds on a species of *Artemisia*, the native name of which is *Godomollo*, and that the butterfly appears in December. Just beyond the tropics, at the Cape of Good Hope, Trimen reports it as found in the imago state throughout the year, but most abundant from September to March. At about an equal distance north of the tropics, on the same continent, in Egypt, this butterfly flies through the winter, and from November to March caterpillars in almost every stage may be found upon a species of *Malva*, called by the Arabs *Mlukheh*, while the thistles growing abundantly by the railway lines are untouched. These fragments comprise the account of this butterfly outside of Europe and North America, and the following remarks are confined to this insect as it exists in north temperate regions.

In New England this butterfly is double-brooded and hibernates in the imago state.[1] The hibernating butterflies do not usually begin to emerge from their winter quarters until the middle of May, and badly worn specimens continue to fly until after the middle of June. They lay their eggs during the latter half of May and early in June; these hatch in from six to eight days, and the caterpillars therefrom become fully grown between the middle of June and the middle of July; the chrysalids hang from eight to fourteen days, and disclose the first fresh butterflies about the 10th of July. These usually become abundant by the middle of the month, and at the end of the third week innumerable; they continue to emerge from the chrysalis until the early days of August, and fly until the next brood appear; these lay their eggs during the last of July and first of August, and the caterpillars

[1] At least so far as is known. In Europe, according to some writers, it often passes the winter in the chrysalis state; but authorities do not agree upon this point.

undergo their final transformations in the latter half of August and early in September, the autumn brood of butterflies first appearing late in August and continuing on the wing until the end of October, when they hibernate.

This account does not correspond with the history of the same insect in Europe. Meyer-Dür states that in Switzerland the butterfly may be seen on the wing from April to the end of June (wintered specimens), and from the middle of August until late in October; that is, it is single-brooded. Many authors speak of it as double-brooded, without mentioning the specific times at which it may be found; while others give the same seasons as Meyer-Dür and call it double-brooded, mistaking the double apparition of the same brood (winter intervening) for distinct broods. My own observations in the neighborhood of Geneva and Paris lead also to the conclusion that the insect is single-brooded; and no entomologist, to my recollection, has given the best proof of digoneutism, namely, two distinctly separated dates for the apparition of the caterpillar. Nevertheless, from the time of Ochsenheimer, who repeatedly says, "Ich habe zwei Generationen bemerkt," different authors have claimed for this insect a double brood; and until direct observation shall have determined the point, it should be considered, at least for some parts of Europe, an open question. In Switzerland and in England all observers seem to agree that it is single-brooded; and this is in direct contrast to the digoneutism of the same insect in New England.

If this were a solitary fact, it would possess comparatively little interest. But if we compare the annual histories of the dozen or two butterflies either actually occurring both in Europe and in Eastern North America, or represented on either continent by intimately allied forms, — if we compare their histories, we shall find several other species which present similar peculiarities, and be led to believe that the case of *V. cardui* is only one illustration of a somewhat general law.

The European *Aglais urticæ*, for example, is generally double-brooded; occasionally a triple brood is mentioned; it is one of the commonest of European butterflies, and reaches from the North Cape to the Mediterranean; our congeneric *A. Milberti* is rarely found south of the northernmost parts of the United States, and yet is triple-brooded in all parts of Canada. *Everes Amyntas*, again, occurs throughout Europe, with the exception of certain northern and northwestern portions, and is double-

brooded; our *E. Comyntas*, named for the resemblance to its European congener, and by some careless authors considered identical with it, is also a wide-spread insect; but even in New England, which is toward the northern limit of its range, it is triple-brooded. The wide-spread European blues, *Argus* and *Aegon*, are usually placed among monogoneutic insects, and the latter certainly has but a single brood in England (where it is the only one of the two found); Meyer-Dür is in fact almost the only author who claims these species as digoneutic; both of them occur in Southern Europe; the American *Scudderii*, closely allied to these and an insect hardly known south of the Canadian border, is double-brooded. Our *Pontia Protodice* is triple-brooded, and the European *P. Daplidice* only double-brooded, while our common species of *Eurymus*, *E. Philodice* and *E. Eurytheme*, are triple-brooded in the north (perhaps polygoneutic farther south), and the closely allied European species only single or double brooded.

But the most striking example of all will be found in the species of the genus *Iphiclides*. The European *I. Podalirius* is confined to the Mediterranean region, while our *I. Ajax* belongs to the southern half of the United States; the regions are therefore fairly comparable; yet we can find no mention of more than two broods of *I. Podalirius*, while Mr. Edwards has shown that, even as far north as the Appalachian valleys of West Virginia, *I. Ajax* has four and sometimes five generations during the year; moreover, the first of these generations is dimorphic, and the dimorphism has in it the semblance of a seasonal character, the earlier individuals being of one type and the later of another.

These cases might perhaps be multiplied, but further positive evidence is not at hand; it should be remarked, however, that there is no reversal of this rule; among all the butterflies properly comparable on the two continents, there is no single instance where the European butterfly has more broods than the American.

This result of a comparison of the annual histories of similar European and American butterflies furnishes but another instance of that intensity which seems to characterize all life in America. The expenditure of nervous and vital energy, against which physicians vainly inveigh, which superannuates our merchants, lawyers, clergymen, and other professional men, is not induced by the simple passion for gain, place, power, or knowledge, but by an uncontrollable restlessness, a constant dissatisfaction with

present attainments, which marks us as a hurrying, energetic, enterprising people. My own experience has been that studies of precisely the same nature and undertaken under similar external conditions are accompanied by a very different mental state on the two continents. In Europe we are content to plod industriously on, unconscious of the need of relaxation; in America we bend with nervous intensity to our work, and carry the same excitement into the relaxation which such a life inevitably demands. After a long absence in Europe, a keen observer may even be directly conscious of this quickened life.

Now to what shall we ascribe such peculiarities in animal life? Naturally we look to climatic influences, and our attention is first attracted by the well-known fact that, if we compare two places in Europe and America having the same mean annual temperature, the extremes of variation will prove much greater on this side of the Atlantic. For example, while the mean annual temperature of New York is about the same as that of Frankfort, the summer temperature of the former is that of Rome, and its winter that of St. Petersburgh. Moreover, the changes from summer to winter and from winter to summer are more immediate in America, or, in other words, the summers and winters are longer (by about three weeks). Such long and hot summers are of course favorable to the multiplication of broods in butterflies whose history allows a repetition of the same cycle more than once a year; the length of the winter is of slight consequence, as long as the insects can survive it; and it can have no influence upon the number of broods, unless there be species (of which we know nothing) able to resist a cold winter only in certain stages of existence, and a multiplication of whose broods might require some pliability in this respect. Not only, too, are our summers longer and hotter, but they enjoy a marked preponderance of sunshine, as compared with European summers; and this alone would almost seem capable of producing the variation we have noticed in the number of broods.

Differences will be found in all other climatic phenomena of the two continents. "From Europe as a standard," says Blodgett,[1] "the American climate is singularly extreme both in temperature, humidity, quantity of rain, winds, and cloudiness or sensible humidity. The oscillations of the conditions are greater, and they vibrate through long measures above and below the average. All the irregular as well as regular changes are of this

[1] Climatology of the United States, page 221.

sort, and the European observer defines the climate as directly antagonistic to that he has left." These differences, however, as Humboldt and others long ago pointed out, have a broader bearing than the above statements alone would imply; for they are characteristic of the eastern shores of both worlds as opposed to the western, the meteorological phenomena of the eastern United States being almost precisely paralleled by those of Northern China, where great excesses of temperature occur, with wide variability, long summers and winters, and rapid transitions.

Perhaps on these grounds we can most simply account for the difference in the number of broods in certain butterflies on the two continents; but, if so, then it follows that we ought to anticipate similar differences between the broods of some of the species found both in Europe and in Eastern Asia; a point of which we can assert absolutely nothing, for want of data. These grounds, however, will certainly be insufficient to account for the differences to which we have alluded in man; for what contrast could well be greater than that existing between the national character of the Chinese and that of the Americans! We are rather forced to believe that the causes of the distinctions between the European and the American, if these are at all due to physical agencies, must chiefly be sought elsewhere. From my slight knowl edge of the climatic features of Eastern Asia, it is impossible to contrast Eastern North America with the north temperate regions of the Old World, taken as a whole; certainly the greater frequency and intensity of electrical phenomena on our shores may have some influence.

But to return to the history of our cosmopolitan butterfly. We have traced the sequence of events in its life; let us now look more closely at some of the habits peculiar to it in either the earlier or the later stages of its existence. The ovipositing female alights upon a plant and moves about with trembling wings, and body generally on a line with the midrib, until it finds a spot to its taste; the wings, elevated at an angle of about forty degrees with each other, now become quiet, the tip of the abdomen is bent down upon the leaf, and the egg is instantly laid. I observed one butterfly alight many consecutive times on unopened thistle-heads, thrusting her abdomen between the spines to the very sepals, as if in act of ovipositing; but no egg was laid until she alighted on a leaf. The same butterfly appears never to lay more than a single egg upon one leaf, although she frequently deposits eggs on different leaves of the same plant, and in one

particular instance laid them upon cut leaves lying on the ground; in this case she laid them upon the uppermost surface, whichever way the leaf was turned; on the plant they are always laid upon the upper surface; and I once found an egg on a spinous hair of a thistle leaf. Several eggs may sometimes be found on the same leaf, but they will always hatch at different times, showing that they were laid on different occasions, if not by different individuals. The eggs themselves vary considerably, their vertical ribs ranging from fourteen to nineteen, and averaging fifteen and a half or sixteen in number; judging from the examination of forty or fifty specimens, it would seem as if the average were slightly greater in America than in Europe.

The caterpillar feeds principally on *Compositæ* and especially upon the tribe of *Cynareæ*, or thistles. In our country it has been found on *Cnicus benedictus*, *Cirsium lanceolatum* (the common thistle), *C. arvense*, *Carduus nutans*, *Silybum Marianum*, *Onopordum acanthium*, and *Lappa major* (burdock), — all plants introduced from Europe; also on *Senecio cineraria*, belonging to another tribe of *Compositæ;* on another of the *Compositæ*, one of the sunflowers, *Helianthus sp.*; on *Althæa rosea* (garden hollyhock), — again an introduced plant, and one of the *Malvaceæ;* and it is reported (perhaps by mistake for its congener, *V. Atalanta*) to have been found on the nettle. Möschler remarks that he has received neither thistles nor nettles from Labrador, and wonders upon what the caterpillar may feed in that inhospitable region. In Europe it has been taken upon various species of *Carduus*, *Cirsium*, and *Onopordum*, and other *Cynareæ*, such as *Centaurea benedicta* and *Cynara Scolymas;* some *Senecionidæ*, such as *Achillea millefolium* and *Gnaphalium arvense;*[1] on *Echium*, one of the *Borraginaceæ*, and on *Malva rotundifolia*. It seems to prefer the *Malva* in Egypt, being found abundantly on the species cultivated by the Arabs for medicinal purposes; and since this is cut at various times during the winter, myriads of the caterpillar are doubtless annually exterminated.

The young caterpillar makes its escape from the egg, as usual among lepidopterous larvæ, by biting a slit almost around the crown of the egg, and pushing up this improvised lid; it does not appear to devour the egg-shell, as caterpillars usually do, but, after biting a few little holes partly through the upper surface of the leaf, makes its way to the opposite side and takes up a position, each one apart from its fellow, either between the

[1] Horsfield, as we have seen, raised it in Java on *Artemisia*.

midrib and curled-up rim if near the tip of the thistle leaf, or next the midrib or a lateral rib, if farther back; here it bites away the silken film and makes a nest, covering itself with a slight open web, into which it weaves the bitten particles of the film. From this retreat it sallies forth to eat irregular patches in the parenchyma, which it often partially covers with an extension of the web.

Each caterpillar, when it has outgrown this confined abode, builds for itself a separate nest, generally near the summit of a stalk; it spins a thin web on the surface of the leaf, near the edge, if it be a broad-leaved plant, and then draws over a portion of the leaf by means of threads, completing the covering with a silken tent; when half grown it forsakes this and forms a more perfect nest, drawing together leaves, buds, and bitten fragments by the same process, so as to form an oval cavity, about thirty-five millimetres long vertically, and a little more than half as broad. The narrow, irregular, crisped, and rather distant leaves of the thistle, on which it is most frequently found, cannot, however, be made to cover even a single caterpillar, and the spaces are closed by a thin open web, through which the inmate can readily be seen, but which is sufficiently close to retain all the rejectamenta of the caterpillar. The nest is usually covered, at least in the upper half, with spines of the plant, evidently bitten off for the purpose; there is an opening in the nest, near or at the summit, just large enough to allow the larva to emerge, apparently made by eating away the web. The leaves which penetrate the nest are not lined with silk, but the web is frequently stretched across the inequalities of the leaf. Within this habitation the larva rests with its head downward, like its congener, *V. Atalanta;* but, unlike it, when its earlier stages are passed, it feeds upon the upper surface and parenchyma of the leaf, without touching the under cuticle, and when these are consumed, it crawls out to seek its fortune and weave a more commodious mansion; when, however, it has reached its final stage, it devours the entire leaf.

When about to undergo its transformation, the caterpillar does not wander far, and frequently remains upon the plant which has nourished it. A specimen bred in confinement, but which had abundance of room, formed of partially dried leaves, connected by open, angular, irregular, silken meshes, averaging about four millimetres long, a sort of cocoon, of no definite shape, but larger than its previous nest, and which it attached to the top of the cage.

The butterfly is particularly fond of fields, gardens, highways, open ground, and waste places; it frequently alights on stone walls heated by the sun, and is greatly attracted by flowers, particularly by thistles and the other plants upon which the caterpillar feeds; here it may readily be taken; not so in other spots, for although very fearless, and even impudent, it is exceedingly wary, dashing off headlong at the slightest alarm. In Florida, Dr. Chapman once found three or four entangled in the leaves of a Sarracenia.

Its flight is rapid, dashing, and discontinuous, it doubles frequently and abruptly, usually to the right or left rather than up or down, although it has no predilection for a particular elevation above the ground, as some other butterflies have; in these frequent changes it makes a series of spasmodic efforts, the movements of the wings being more vigorous during the initial half of each start, or perhaps confined to that period. It loves to return to the spot from which it has been driven, or to the immediate vicinity, often circling about first, as if selecting the best spot. On a windy day its flight is not a little remarkable; it rises high in the air, then suddenly darts down until it has approached within five or ten metres of the ground, when it starts upward again to repeat the process. On a warm, sunny day, it frequently flies until within half an hour of sunset, and it may be seen laying eggs at almost any hour between ten and four.

"Its wildly timorous behavior," says Meyer-Dür, "is quite striking; it is uncommonly audacious; swift and savage, it dashes irregularly about; scarcely observing the pursuer, heedless of the net, it returns directly to the place it has left, and sits with horizontally opened wings on the dry earth or spots of sand. It is a nimble, lively, youthful, untamed, petulant insect, which shows in its behavior no resemblance to its proud but circumspect neighbor, *Atalanta*."

On alighting, it partially or wholly expands the wings; when fully spread, they are brought well forward, and are often even slightly depressed; the straight antennæ are then spread at an angle of ninety degrees and lie in the plane of the body, or perhaps slightly elevated.

Although its habit is to alight freqently, its flight is strong and well sustained. Trimen relates that a specimen flew on board a vessel in which he was sailing, when about ninety miles from Teneriffe. Reference has already been made to one of these butterflies visiting a vessel six hundred miles from the main land dur-

ing a cyclone, and other similar though not so striking instances might be added. Several accounts have also been given of the migration or simultaneous movement of this insect in swarms. Dr. Hagen records two instances;[1] on October 26, 1827, Prevost saw such a moving swarm, composed of a stream of butterflies from ten to fifteen feet broad, passing from south to north for two hours. On April 26, 1851, Ghiliani saw, near Turin, a great flight of these insects; according to Bouquet,[2] the day was fine, after continued rain, and a strong breeze blew from the west; commencing at eleven A. M., the swarm came from the south-southeast and continued with a precipitate flight for five hours towards the north-northwest.

"In England and on the continent of Europe," says Trimen,[3] "*cardui* sometimes appears in great abundance, and then, perhaps for several seasons, will be uncertain in appearance and restricted to particular localities. I have not heard of this irregularity of appearance being noticed in other parts of the world." This is, however, the universal testimony of observers in America, and is probably due to the action of parasites. It was one of the first phenomena that drew my especial attention to butterflies. This butterfly, indeed, is one of the best subjects of study for those who wish to investigate the causes of irregular apparition; and only such as spend much time in the field can hope to solve the problem. A close observation of the comparative abundance of the butterfly for several consecutive years in the same locality, accompanied by an attempt to rear hundreds of the caterpillars (selecting only those which are nearly full grown, and recording the proportion of healthy and infested ones), will probably show whether the attack of parasites is a *vera causa*.

As regards the parasites, Prof. A. E. Verrill has reared from caterpillars of this insect a species of *Microgaster* called *M. fructuosus* by Cresson. Mr. Riley has also bred a dipterous parasite; its larva usually issues from the victim while the latter is in the caterpillar state, though sometimes not until it has transformed to chrysalis; and in one instance the *Vanessa* completed its metamorphoses with the parasitic fly yet in its abdomen; it did not, however, properly expand its wings. Mr. Riley has also bred *Ichneumon rufiventris* Brullé from this insect; this hymenopteron issues from the anterior extremity of the chrysalis, infested spec-

[1] Stett. Entom. Zeit., xxii. 80.
[2] Annales Soc. Ent. Fr. [2] ix. Bull., 56.
[3] Rhop. Afr. Austr., 121.

imens of which may always be recognized by their pale color. In Europe, the caterpillar is infested by the larvæ of a *Microgaster;* parasites reared by me perforated the skin of the caterpillar August 19th and made their cocoon on its body. September 4th the box containing the cocoons was opened, disclosing both dead and living imagines; they belonged to two distinct species, those of the smaller being dead and dry, while those of the larger were either living or recently dead; on the succeeding day the remainder of the larger ones appeared, and proved to be, as identified by my friend Mr. Drewsen, of Copenhagen, *Microgaster subcompletus* var.? von Esenb., and the smaller an undetermined species of the same genus, probably undescribed. Of the former 3♂ and 15♀ emerged; of the latter 8♂ 3♀; besides these, four larvæ had been taken from their cocoons and preserved in that state; all of these came from the body of a single caterpillar. The larger species is probably the actual parasite of *V. cardui;* the latter, a parasite of the parasite.

AQUARIA: THEIR PAST, PRESENT, AND FUTURE.

BY WILLIAM ALFORD LLOYD.

EIGHTY-SIX years ago — in the year 1790 — there might have been seen trudging along the streets of Edinburgh an "old blue-coated serving-man," carrying an earthenware pitcher or jar, of three or four gallons' capacity That pitcher contained sea-water for the marine aquarium of Sir John Graham Dalyell, Bart., who thus employed a man, or probably a succession of men, from the time he began aquarium-keeping till he finished at his death in 1851, a period of sixty-one years. The jar was sent to the sea to be filled twice or thrice weekly; but averaging it at five times a fortnight, and allowing four miles for each double journey from Great King Street to the sea and back, that amounted to 39,650 miles from the year 1790 to the year 1850, which was an enormous and perfectly needless expenditure of force, expressed in time and money, even although the results of Sir John's investigations were given to the world in five such important quarto volumes as his Rare and Remarkable Animals of Scotland, 1847–48; and his Powers of the Creator displayed in the Creation, 1851–58.

Dalyell's mode of operation, as told to me by his sister Elizabeth, in two letters dated 1860, and printed in the *Zoölogist* of

November, 1873, vol. viii., second series, pp. 2757, 2758, was as follows: He kept his living marine animals, consisting of the lower kinds below fishes, in a number of glass cylindrical jars, of various sizes and proportions, and with usually one animal in each. The water in these jars he changed every morning, "often twice a day, if he perceived the smallest fragment amongst it, wiping and washing the glasses very clean." He then drew away the water so used, and replenished it from the earthenware jar with the water got from the sea. At one time I should not have termed this aquarium-keeping at all, because of the change of water. (See Crystal Palace Aquarium Handbook, 1875, p. 7.) But now, having got to think more broadly, I recognize this, not as a change of water in the sense of its being lost, but merely as a change of position from a house in Edinburgh to the sea, and back again. That is to say, the water he dismissed from his jars went into a gutter in a street, or into a sewer below it, and found its way by gravitation into the ocean again. Or, if it were poured on the ground, into which it soaked, it found its way back to the sea by an infinitely more circuitous route. But had Dalyell been more of a general philosophical thinker as well as a naturalist, he would have saved himself this very great amount of cost and trouble. Had he but reflected on that which was then known, namely, that water — both sea-water and fresh water — is practically indestructible, and that any decaying organic matter, animal or vegetable, or both mixed, can be got rid of, and the water be left pure, then he would have saved his servants their weary walks of more than as far, in their aggregation, as twice round the world, nearly.

In the ocean, of course, various animals and plants are incessantly dying in large numbers, and their decomposing remains are prevented from permanently poisoning the water, in which other animals live and breathe, by the incessant motion to which the sea is subjected, and this motion brings the water into purifying contact with the atmospheric air which everywhere exists. It is this air, or rather the oxygen in it, which the water takes up in greater quantity than the nitrogen, which is another and larger component of the atmosphere, which is the source of purification alluded to, the water being merely a medium or a vehicle for the exhibition of the oxygen. In addition to this, vegetation grows by the action of light, and decomposes the poisonous carbonic acid gas evolved by the breathing of animals, the carbon being used to form the woody substance of the plants, and the

residual oxygen being liberated for the use and benefit of the animals. Thus the ocean, and rivers, and lakes, and all other waters in nature, of varying degrees of freshness and saltness, by motion and vegetation, both originating from the sun, are maintained sufficiently pure and respirable.

These operations were going on almost at Dalyell's door, yet he did not learn to apply them to practice, as he might have done. What he did was this: He fed the animals in his jars on mussel flesh, which is easily diffusible in water, and which quickly makes it milky; and this, with the absence of growing vegetation, and the breathing and other emanations of the animals, soon caused the water to become offensive in appearance and in smell. So he threw it away. But the very act of pouring it, and the motion of it as it trickled onward to the sea, purified it, because such an act was an unconscious imitation of what nature does. Had Sir John but thought of the merely vehicle character of water, and of its incapability of being decomposed save by a very slow and expensive process, he would at once have seen that the minutely disseminated mussel flesh and its juices in the water made that water unfit to support life, only temporarily. It was not the water itself that was not fit; it was only something in the water that was wrong, and if that something were removed the water would be left as good as ever. If, therefore, instead of sending it back into the sea by a long road, and then going to the immense pains to dip it back again, he had poured it into a large receptacle in his own house, such receptacle or reservoir being many times larger than the aggregate contents of all his glass jars, he would have found that in a short time he would have possessed a source of supply for the jars quite as good as the ocean provided. Had he, in addition, placed his reservoir in a cool cellar, and had a pipe connecting it with the study to which Miss Dalyell has incidentally alluded, with a funnel at the upper end of the pipe, in which was placed a piece of straining-cloth or a small hair-sieve, to arrest the coarser pieces of decaying organisms, and if he had poured the water he had used into this funnel, the arrangement would have been still better. Yet better would it have been had he possessed another pipe leading upward from the reservoir, through which he could pump up the sea-water as he wanted it. Best of all would have been some form of incessantly-working machinery, by means of which the water would be always coming up, day and night, from this large and cool reservoir into the experi-

mental glasses, for then they would have been constantly kept at an even temperature and in a state of constant aeration. This would have done away with the necessity of the everlasting wiping and washing of the glasses; and, they being thus left alone, and in a certain amount of daylight, vegetation would soon have appeared in them, stimulated by the action of that light, without having been visibly introduced, but present everywhere in the seeds or spores of plants, merely waiting to be developed. Such an arrangement, indeed, would have been precisely that of the best modern aquaria as now made, in which the water is so continually and abundantly aerated by ceaselessly moving machinery that impurities have no time to accumulate, but are oxygenated and dissipated as quickly as they form. In the Brighton and Havre public aquaria, the old and intermittent system used by Dalyell has been reverted to, and of course with ill results, as the water freshly obtained from the sea is turbid when seen in large masses, and is unhealthy for the animals, only a small number of which therefore can be kept in great bulks of fluid, because it is insufficiently aerated. This will be the case also at the Scarborough aquarium, now being built on the same erroneous principle.

Dalyell, however, was no mechanician or physicist, and he knew nothing of marine botany; so he just did as his neighbors did with their fresh-water gold-fish globes; he changed the sea-water and threw it away as quickly as it became sullied, and this water he obtained at no great cost, he living close to the sea. Or if the cost of time in getting it was considerable in proportion to the work done, *i. e.*, the quantity obtained, it mattered not much to him, as he was a rich man. Yet, had he but known it, the sea-water he thus obtained was less good for the animals he kept than it should have been, inasmuch as it was from the adjoining Firth of Forth, and of the density of but 1.024, at a temperature of 60° F.; whereas had he kept it for some months, it would have evaporated to the more proper density of 1.027 at 60° F., taking distilled water as being 1.000 at 60° F.

I have given this narration as showing the state of things aquarially at the end of the last century, and during the first half of the present one, and also as being the mode of operation which the general public, and even the great mass of the higher and better educated classes of society, still believe to be the system necessary to be followed in the maintenance of aquaria.

In the year 1842, the late Dr. N. B. Ward published the first

edition of his book, in 8vo, on the growth of plants in closely glazed cases, and this in 1854 was followed by the second edition, in 12mo. In 1853, Dr. N. B. Ward's son, the present Dr. Stephen H. Ward, gave a lecture on this subject at the Royal Institution, which was published as a 12mo pamphlet in the same year. All three of these are now and have been long out of print, and they bear testimony, indubitably, that N. B. Ward experimented with aquaria about the year 1840, though he did not use the word "aquarium," which was employed for the first time in print, as far as I know, twice by Mr. P. H. Gosse, in his Devonshire Coast, post 8vo, 1853, at pages 234 and 441. That is to say, N. B. Ward is the earliest recorded person who *intentionally* arranged together certain animals and plants in water, so that these two sets of organisms should mutually and partly support each other, the plants giving off oxygen and taking up carbon, and the animals taking up oxygen and giving off carbon, thus decomposing and rendering harmless the carbonic acid gas as continually as it was evolved by the animals, and maintaining the water pure. In Dr. S. H. Ward's pamphlet, just named, is a long, circumstantial, and most interesting narrative of how Mrs. Anne Thynne did the same thing precisely with sea-water and marine animals and plants. This lady being in London in the year 1846, and having some living corals and sponges, used to send occasionally to the coast for supplies of water for her creatures. But finding that if a quantity of this water were taken up in a jug and let fall again from its spout in a slender stream, it lost whatever impurity it contained from contact with air in this much comminuted state, she ceased to get more from the sea, and instead got from thence some living sea-weed and placed it in the water, which derived additional benefit from this vegetation, just as Dr. N. B. Ward found his fresh water had benefited by the plants he introduced. It is more than probable, however, that in both these instances the really beneficial vegetation was not that which was thus visibly introduced, but was the minute kind which grew parasitically on the plants and upon the inside of the vessels. Yet it must be admitted that this gentleman and this lady are the two first known persons who, keeping a chemical law in view, deliberately and purposely set about attaining means for its fulfillment in an aquarium.

In 1849, the late Mr. Robert Warington, chemist to the Company of Apothecaries, set up in his rooms, in the hall of that

company, in London, his first aquarium, a fresh-water one, followed, in 1851–52, by his first marine aquarium. These he described in the periodicals of the day, and also in a lecture which he gave at the Royal Institution, in an interesting manner, and naturally from a chemist's point of view. At about the same period Mr. P. H. Gosse commenced his earliest marine aquarium, as did Dr. J. S. Bowerbank, Dr. Cotton, and the late Dr. E. Lankester, and the successes attained by these experimenters induced the Zoölogical Society of London to determine to have a public aquarium in its gardens in Regent's Park. The building for this purpose was erected in the spring and summer of the year 1852. The marine and fresh-water animals were begun to be introduced in the late autumn; the following winter and spring were wisely spent in experimenting on the best modes of operating, and the exhibition was opened on May 21, 1853. After having been noticed in print by the *Athenæum* of some months earlier, it was again commented upon by that journal of May 28th, and by the *Illustrated London News* of the same day and year, the latter publication giving views of two tanks. One of the earliest services which this institution conferred on biological literature may be seen in portions of the natural history division of the English Cyclopædia (an adaptation of the earlier Penny Cyclopædia), as the former publication appeared fortnightly, commencing in the spring of 1853; and as it was edited by Dr. E. Lankester, who always took much interest in aquaria, he mentions in the book from time to time that such and such animals named had been kept in this Regent's Park aquarium, to which he gave the needlessly long name of "aquavivarium." This place was my own much loved and earliest place of natural history studies, and in August, 1853, I too arranged a little domestic aquarium of my own — a fresh-water one. Later in the same year I set up a small marine one, or rather a series of little aquaria in glass jars, holding from half a pint to a pint each. Seldom has a student begun with such very small means as I then possessed, for my sea-water was compounded of salts purchased at a London chemist's shop, and my animals were such little sea-anemones as I could find uninjured on oyster shells thrown into London streets. I was in earnest, however, and the difficulties I was so closely beset with, and they alone, enabled me to gain subsequent success. In the earlier books on aquaria — notably in Mr. Gosse's two volumes, his Devonshire Coast and his Aquarium (the

latter having gone through two editions, 1853 and 1856, besides a recent reprint without the plates, which have been accidentally destroyed) — aquaria are associated in idea with conservatories, especially as to the growth of plants in each. This notion was very natural. Accordingly the Regent's Park Aquarium was made virtually as a conservatory. But it was a diametrically wrong notion, as the first summer proved; and the second summer (1854) showed this still more conclusively; and the third (1855) yet more so, the evil being an accumulating one. It was then remembered, when too late, that marine and fresh-water plants and animals live in seas and rivers, where the temperature is much more restricted in range than that which obtains in the atmosphere.

It was seen that success was to be obtained by representing these conditions of nature just named, and that to place such organisms in a glass house, where the rays of a summer's sun heated a mass of imprisoned air, was to kill the animals and to stimulate the plants to unnatural growth, or rather to cause them and some of the animals to be covered with a parasitic growth of the lower green algæ, which obscured them. The errors of this earliest aquarium were strikingly shown by its solitary merit, the latter being its fresh-water division, occupying one side of the building, where the water coursed through the tanks in a constant stream, it being clear and cool, and peopled with an adequate number of healthy animals; while on the other side of the building, and in its centre, were the marine tanks, in which the water was, and still is, turbid and warm, and sparsely inhabited by not healthy creatures.

These good results were, however, obtained by accident and not design. The society possessed already a steam-engine, which pumped up water for the general use of its gardens, and it was a mere matter of course to connect the aquarium with this engine, and allow the water (which *chanced* to be drawn from a pure source) to run through the fish tanks, and then be applied to ordinary purposes, drinking or other, for which its passage through the tanks in no way unfitted it. I reasoned with the society that if the sea-water tanks were similarly treated on some such system as the fresh-water series, a correspondingly good result would be attained; and I pointed out that the same law governed both, because in the centre of the building were some isolated fresh-water tanks having no stream in them, and these were in a similarly ill condition as the marine tanks by

their side. In reply, the society answered that a circulatory system did exist in a part of the sea-water series, but that it was almost useless; and I then pointed out that that was because the reservoir into which the sea-water entered after it had run through the show-tanks was too small in relation to the dimensions of the latter, and that the reservoir should be several times greater than the show-tanks. My reasoning was all in vain, however, for the society went on throwing away the sea-water when it was only *temporarily* unfitted for use, and getting at a cost of several hundreds of pounds yearly a weekly supply from the sea, especially when soon afterwards another evil made its appearance, consisting of a greenish-brown dense opacity, permeating the water and quite hiding from view all it contained. This was caused by excess of light, for I found that darkness removed it and made the water clear again; and this led to Mr. E. Edward's invention of the dark-chambered tank, a modification of which is now, or should be, employed in all public aquaria where adequate results are aimed at and attained. So, at this early period, 1853–62, though in theory the Zoölogical Society of London, and every one else who maintained aquaria, used the same unchanged water, especially sea-water, yet most persons sent to the sea, or to dealers, of which I was then one, for occasional new supplies. However, from 1853 to 1855, when I could not possibly get new sea-water for my little jars, I merely increased the quantity of water to about eight or ten times as much as those jars collectively held. Thus the aggregate contents of my jars were about six or eight pints; and in a now historical earthenware foot-pan, kept dark in a cool corner at hand, I had five or six gallons more water, containing neither animals nor plants, and when aught occurred to disturb the equilibrium of life in these jars, either from excess of light or heat by standing on a light window-sill, or from excess of food, or from there being too many animals in a small space, instead of throwing away the water thus *temporarily* rendered unfit to sus tain life, I merely restored it to a right condition by pouring the contents of these jars into the foot-pan, which was so large in relation to the dimension of the jars that I could immediately dip them up full from it (the foot-pan) without the water being perceptibly the worse for it, especially when I so contrived matters that these transfers were made, not in one day, but on successive days. Thus, in London, far from the sea, which I had never seen, I was so far, aquarially speaking, as well off as the

wealthy Sir John Graham Dalyell, with the ocean almost at his door. Later on, in 1857–58, I set up another marine aquarium, in which the show-tank held twenty gallons, and the reservoir five hundred gallons of water, in which that water, instead of being intermittently circulating, as in my jar and foot-pan arrangement, circulated constantly, day and night, by means of a pump and pipes, in a cool underground London cellar or kitchen, with a uniform temperature of about 60° F. This answered excellently, especially when I increased the water in the reservoir to one thousand gallons.

As the more air there is in the water the better it is, hence the value of large and therefore cool reservoirs. Independently of all this, however, the larger the bulk of water, and the more constant and vigorous the circulation and aeration, the less it will be sullied by the animals which live in it. In the Crystal Palace Aquarium we have in the show-tanks twenty thousand gallons of sea-water, and in the reservoir one hundred thousand gallons, total one hundred and twenty thousand gallons, supplied by Mr. W. Hudson in 1870. Yet in this comparatively small quantity of unchanged fluid we have, from September, 1871 to March 31, 1876 (four and a half years), given to the animals in it the following enormous quantity of food without the water being otherwise than always sparklingly clear: —

1.	Sandhoppers (*Talitrus*), in pounds weight	12
2.	Shrimps (*Crangon*), in quarts	4735
3.	Crabs (*Carcinus*), in gallons	137
	" (*Cancer*), large, " numbers	1450
4.	Scallops (*Pecten*) large, in numbers	32
5.	Oysters (*Ostrea*) " "	2195
6.	Cockles (*Cardium*), in gallons	18
7.	Mussels (*Mytilus*) "	3544
8.	Whelks (*Buccinum*) { in gallons	7
	{ " numbers	100
9.	Fish, chiefly Whiting (*Gadus*), in pounds weight	3159
10.	Smelts' roe (*Osmerus*) " "	14
11.	Green sea-weed (*Ulva*), purchased "	400
12.	" " (*Conferva*), grown in tanks, quantity unknown.	

And, in addition, we obtain occasional and unrecorded supplies from neighboring fishmongers when the regular supply runs short. Of this animal food, all but the denominations nine and ten are kept alive in a series of reserve tanks till the moment of being eaten. Scarcely any uneaten food, and never any excrement, is manually removed; but all which is not consumed by the animals is chemically dissipated, without filtering, by the enormous volumes of air constantly being injected into every

tank by Leete Edwards and Norman's machinery, the speed of which is accelerated (*i. e.*, the oxygenation is quickened) when the water is slightly turbid from an excess of organic matter. All this I have explained more at length in the Official Handbook to the Crystal Palace Aquarium, and in Observations on Public Aquaria, both published at the Crystal Palace. It is this power of oxygenating, or consuming, or burning, at a low temperature, termed by Baron Liebig "eremacausis,"[1] which expresses the real work done in an aquarium, and the force necessary to do that work. Even our thick beds of sand and shingle at the bottom of each tank are so fully charged with air that one thrust of a stick will release a pint of it in bubbles. This is a source of purification and health quite unknown till recently. Consequently the floors of our tanks (excepting the sea anemone tanks) are as speckless and as free from the blackness caused by sulphureted and carbureted hydrogen gas, as on the day they were laid down in 1870. If we have an excessive growth of sea-weeds anywhere, we turn in a shoal of gray mullet (*Mugil capito*), which nibble it down close, like sheep in a field of grass. This leads me to say that at present we do not know how to grow the higher marine algæ, the red, the brown, or even the green kinds, at will. Sometimes I succeed, but always by chance, not knowing why.

Of the general influence of aquaria on zoölogy we have curious evidence in Mr. Gosse's most excellent Manual of Marine Zoölogy for the British Isles, published in two volumes, in 1855–56, in which the author enumerates 1785 species, from sponges to fishes, and of which he figures 779 genera, always preferring to draw from living animals whenever possible. Now, as at that period a larger number of aquarium animals had passed through his hands than through those of any other person, he may be presumed to have, up to then, seen more of them alive than any one else. Yet he enumerates only 201 as having been drawn from life, as he avowedly preferred doing, and of these but a dozen were fishes, others being, for the most part, small creatures, or those which are easily maintained and do not need large tanks and elaborate machinery. But during the twenty years which have elapsed since 1856 I have seen and handled and had under my care, in England, France, and Germany, about 433 species of British marine animals, of which 112 were fishes.

[1] From the Greek "to remove by burning, or by fire." The words "caustic" and "cautery" have the same derivation.

There are few things more trying to that great virtue, patience, than a large public aquarium, especially in its preparation, before it is ready for the reception of animals. It is to this lack of patience on the part of the directors of the Royal Westminster Aquarium, and to their absolute refusal to allow me to have proper engineering assistance during its construction, and to general mismanagement, that its present confused state, and its unsatisfactory condition in every way, is due. On this account I resigned my post of adviser to the society, as I found it useless to advise when advice was recklessly disregarded. Aquarium work, being hydraulic engineering on a small scale, is essentially the work of an engineer, and not that of an architect, unless he is also an engineer and a mathematician. There is for aquaria a great and important future, both as regards their influence on science and as pecuniary speculations, if indeed, as I much doubt, there can be any real severing of these two interests. Success, however, must always be the result of a careful study and representation of what nature does, and of a strict avoidance of the recent heresies to which I have in this communication adverted. — *Popular Science Review.*

RECENT LITERATURE.

TWO YEARS IN CALIFORNIA.[1] — This book contains apparently a reliable and useful account of California, its scenic and climatic features, its people, with hints for tourists and settlers, and a candid chapter on the Chinese in California. The authoress gives these people credit for a business sagacity, fidelity, industry, and economy which render them a desirable class of immigrants. By their aid, it is claimed, the natural wealth of California has been advanced beyond what it would otherwise have been by a quarter of a century. The literary execution of the book is not rarely capable of improvement, but the work is the result of an honest attempt to impart the fruits of close observation during a two years' residence in California.

COOK'S MANUAL OF THE APIARY.[2] — A cheap and reliable manual of bee-keeping has been needed by amateurs and beginners in the art, and here we have in print Professor Cook's lectures on the subject, delivered annually to his students, forming a guide which we can unhesitatingly commend as sufficiently scientific and practical. The Italian variety is recommended as greatly superior to the German. As regards the treatment of foul brood, we would inquire whether carbolic acid or

[1] *Two Years in California.* By MARY CONE. With Illustrations. Chicago: S. C. Griggs & Co. 1876. 12mo, pp. 238. $1.75.

[2] *Manual of the Apiary.* By A. J. COOK. Lansing, Mich. 1876. 8vo, pp. 59.

other disinfectants would not prevent the spread of this contagious disease. The description of the queen bee is excellent. Though she has a sting, she can seldom be induced to make use of it. Says our author, "I have often tried to provoke a queen's anger, but never with any evidence of success." Professor Cook adopts the prevalent opinion that the queen's development is conditioned by the richer quality and greater quantity of her food, "perhaps aided by a more ample habitation." We would here inquire whether the temperature of the queen's cell differs from that of the drone or worker cells, in fact, whether temperature as well as richer and more abundant food is not a factor in the production of queens; and, on the other hand, what brings about the production of workers, of which, we are told in this manual, there are from twenty thousand to forty thousand in every good colony. If some one would offer a prize for the best essay on the causes of retardation in the worker bee, and of acceleration in the queen, and another prize for the best essay on parthenogenesis in the honey bee, since the matter is by no means exhausted, he would confer a favor on the public and aid in the advance of physiology. Meanwhile we look to our agricultural stations and colleges for original work in this direction.

Wheeler's Geology of the United States west of the One Hundredth Meridian.[1] — This bulky volume gives the results of several years' work by the survey in portions of our western Territories. It embraces reports by Mr. G. K. Gilbert on portions of Nevada, Utah, California, and Arizona explored in 1871 and 1872, already noticed in this journal, with a second on portions of New Mexico and Arizona explored in 1873. The late Mr. A. R. Marvine contributes a chapter on the geology of the route from Saint George, Utah, to Gila River, Arizona; and there are reports on the geology of certain parts of Utah, Nevada, Arizona, and New Mexico, by Mr. E. G. Howell; on a portion of Colorado surveyed in 1873, by Mr. J. J. Stevenson, and a mineralogical and agricultural report, by Dr. O. Loew. The heliotype plates add much to the general interest of the work.

Appalachia.[2] — This is the organ of the Appalachian Mountain Club, devoted to the exploration of the mountains of the Eastern States, particularly the White Mountains of New Hampshire, which gives evidence of vigor by the publication of the first number of its journal within a few weeks after its fifth meeting. It contains, besides other matter, a number of papers of interest to tourists and geographical students, under the following titles: Atlantic System of Mountains, by Prof. C. H. Hitchcock; A Day on Tripyramid, by Prof. C. E. Fay; Two New Forms of Mountain Barometer, by S. W. Holman; New Map of the White Mountains, by J. B. Henck, Jr.; East Branch of the Pemigewasset, by W. Upham.

[1] *Report upon Geographical and Geological Explorations and Surveys west of the One Hundredth Meridian, in charge of Lieutenant G. M. Wheeelr, U. S. Engineers.* III. Geology. Washington. 1875. 4to, pp. 681. With 13 plates and cuts.

[2] *Appalachia.* Vol. i., No. 1. June, 1876. Boston: A. Williams & Co. Published for the Appalachian Mountain Club. 8vo, pp. 62. 50 cents.

ARCHIVES OF THE NATIONAL MUSEUM OF BRAZIL.[1] — The first number of this new journal, established by the national museum recently founded at Rio Janeiro, contains several memoirs, among them one on the aboriginal remains in the shell-heaps of Southern Brazil, locally called "sambaquis," by Professor Wiener, and illustrated by two plates. Professor Hartt, in charge of the Geological Survey of Brazil, and director of the department of physical science and geology in the national museum, contributes an illustrated article of much interest on Brazilian pottery.

MANTON'S TAXIDERMY.[2] — Though fifty cents is a large price for this little book, and the illustrations consist of three rude diagrams, it is yet sufficiently explicit to enable one to learn how to stuff a bird or mammal if he is unable to take a few lessons from a teacher.

RECENT BOOKS AND PAMPHLETS. — The Preparation and Mounting of Microscopic Objects. By Thomas Davis. Second edition, greatly enlarged. Edited by John Matthews. New York: G. P. Putnam's Sons. 1876. 12mo, pp. 214. $1.25.

Bulletin of the United States Geological and Geographical Survey of the Territories. Vol. ii., No. 4. Washington, D. C. August 4, 1876. 8vo.

Force of Ciliary Motion. By H. P. Bowditch, M. D. (Reprinted from the Boston Medical and Surgical Journal.) Cambridge. 1876. 8vo, pp. 5.

Check-List of the Noctuidæ of America, North of Mexico. II. By A. R. Grote. Buffalo. 1876. 8vo, pp. 20. 75 cents.

Synopsis Cecidomyidarum. Von J. E. von Bergenstamm und P. Löw. Wien. 1876. 8vo, pp. 104.

Beiträge zur Anatomie und Histologie der Pflanzenlaüse, insbesondere der Cocciden. Von E. L. Mark. Bonn. 1876. 8vo, pp. 59.

On the Growth of the Flower-Stalk of the Hyacinth. By A. W. Bennett. Preliminary Note on the Rate of Growth of the Female Flower-Stalk of *Vallisneria spiralis*. (Extracted from the Transactions of the Linnæan Society of London.) 1876.

Micro-Photographs in Histology, Normal and Pathological. 4to. By C. Seiler, M. D., in conjunction with J. Gibbons Hunt, M. D., and J. G. Richardson, M. D. Philadelphia: J. H. Coates & Co.

An Address on Some of the Leading Public Health Questions, etc. By J. M. Toner, M. D. Cambridge, Mass. 8vo, pp. 40.

Ueber die Befruchtung der Nordamerikanischen Yucca-Arten. Von J. Boll. 8vo, pp. 4.

GENERAL NOTES.

BOTANY.[3]

INFLUENCE OF LIGHT AND HEAT ON TRANSPIRATION IN PLANTS — Professor Wiesner has recently examined this interesting subject and has added a few facts to those already known. He shows that both light and radiant heat favor transpiration, or active evaporation from the sur-

[1] *Archivos do Museu Nacional do Rio de Janeiro*. Vol. i., No. 1. 1876. 4to, pp. 30. 5 plates.

[2] *Taxidermy without a Teacher*. By WALTER P. MANTON. Illustrated. South Framingham, Mass. 1876. 12mo, pp. 41. 50 cents.

[3] Conducted by PROF. G. L. GOODALE.

face of plants, but he thinks that the ultra-violet rays have little effect. The well-known fact that green plants transpire more rapidly in the light is explained on the ground of their absorbing the light by means of their chlorophyll, and thereby increasing the tension of the aqueous vapor in the cavities of the plant, and thus favoring its escape. This was studied experimentally by comparison of transpiration of green and of etiolated plants in the light, by researches in the spectrum itself, and by interposing a chlorophyll-solution. The opening of stomata in the light plays only a subordinate part in the increase of transpiration caused by light.

Influence of Temperature on the Germination of Pine Seeds. — Dr. W. Velten states that heating the seeds can exercise upon their germination an effect which is favorable or unfavorable according to their physiological condition; and, further, that the time during which they are heated is an important element, since he finds that a lower temperature for a long time has the same influence as a higher temperature for a proportionally short period.

Botany of California, Vol. I. — This work gives a systematic account of the Polypetalous and Gamopetalous Exogens of California, of the whole eastern slope of the Sierra Nevada and of the ranges adjacent to it on the east, from Arizona to Northern Nevada, and of Southern Oregon. The Polypetalous orders have been elaborated mainly by Professor Brewer and Mr. Sereno Watson; the Gamopetalæ by Professor Gray. Of the high character of a systematic treatise by the authors just mentioned it is quite unnecessary to speak, but we may be permitted to call attention to a few of the special merits of the present volume. There are two keys, one *analytical*, the other *synoptical*, by which the determination of the order of a plant and its place in the system is rendered very easy. In these days when there can be noted a tendency in some quarters to go back to a false indexical method, which secures by hook or by crook merely the name of a plant, somewhat after the fashion of a pick-lock, it is pleasant to observe so effective a protest in the form of a sound, scientific, and yet most helpful brace of keys.

The selection of the type has been made with great skill. The catchwords of the printed page stand out boldly, so that the eye can hardly fail to detect the object of search. And, lastly, there is a good sprinkling of interesting notes of a popular character throughout the work, and much prominence has been given to an account of the geographical range of the plants. With Gray's Manual, Watson's Botany of the Fortieth Parallel, and this work (soon, we hope, to be completed), the study of the plants with which one meets in his journey across the continent is now an easy task. It should be said that we are indebted to the generosity of a few far-sighted citizens of California for the publication of the first volume of this work, for which their own legislature failed to provide. Now, one good turn deserves another, and as Californians (the legislature

of the State perhaps excepted) never do things by halves, we shall hopefully expect to see the other half of this, namely, volume second.

Botanical Papers in Recent Periodicals. — *Comptes rendus*, 82, No. 20. Corenwinder, Chemical Researches respecting Vegetation. (The office of leaves. Fixation of carbon.) No. 21. L. Chailletet, On the Nature of the Mineral Substances assimilated by Fungi. No. 23. Pasteur, On the Origin of Organized Ferments. A. de Candolle, Influence of the Age of a Tree on the Mean Time of Leaf-Bud Expansion. Boiteau, On the Galls occurring on the Leaves of French Grape-Vines. No. 25. Maupas, On Contractile Vacuoles in the Vegetable Kingdom. No. 26. Hartsen, Researches respecting *Cupressus pyramidalis*. Bontin, Note on the Origin of the Nitrates in *Amarantus Blitum*. 83, No. 1. Trécul, The Carpellary Theory illustrated by Amaryllidaceæ. Nylander, The Lichens of Campbell Island. No. 2. Trécul's paper on the carpellary theory continued. Durin, On Cellulosic Fermentation of Cane-Sugar.

Flora, No. 18. Sachs, On Emulsion Figures and the Arrangement of Swarmspores in Water. W. Nylander, Lichens collected by Labalestier in Egypt. Dr. Suerssen, Notices of Vascular Cryptogams collected by Wawza. No. 19. Dr. B. Frank, The Biological Relations of the Thallus of some Crustaceous Lichens. No. 20. Nylander, Additions to European Lichenography. Dr. Prantl, Morphological Studies. De Krempelhuber, Brazilian Lichens. No. 21. J. E. Weiss, Relations of Growth and the Course of Fibrovascular Bundles of Piperaceæ. J. Reinke, Note respecting Recent Account of Apparatus for Demonstrating Growth.

Botanische Zeitung, Nos. 25, 26, 27, 28. Dr. Ernst Reuther, Contributions to the History of the Development of Flowers. No. 29. Solms-Laubach, The Development of the Flowers of *Brugmansia Zippelii* and *Aristolochia Clematitis* L. (continued in the four succeeding numbers of the journal). No. 33. A. W. Eichler, Reply to Reuther's paper mentioned above. No. 34. Professor Schenk, On the Fruit of Fossil Equisetaceæ. Professor Famintzin, On the Formation of Cotyledons.

ZOÖLOGY.

Geographical Variation among North American Mammals, especially in Respect to Size. — Having recently had an opportunity (through the kindness of Professor Baird) of studying with some care the magnificent series of skulls of the North American *Mammalia* belonging to the National Museum (amounting often to eighty or a hundred specimens of a single species), I have been strongly impressed with the different degrees of variability exhibited by the representatives of the species and genera of even the same family. The variation in size, for instance, with latitude, in the wolves and foxes is surprisingly great, amounting in some species (as will be shown later) to twenty-five per cent. of the average size of the species, while in other species of the *Feræ*

it is almost *nil*. Contrary to the general supposition, the variation in size among representatives of the same species is not always a decrease with the decrease of the latitude of the locality, but is in some cases exactly the reverse, in some species there being a very considerable and indisputable increase southward. This, for instance, is very markedly true of some species of *Felis* and in *Procyon lotor*. Consequently, the very generally received impression that in North America the species of *Mammalia* diminish in size southward, or with the decrease in the latitude (and altitude) of the locality, requires modification. While such is generally the case, the reverse of this too often occurs, with occasional instances also of a total absence of variation in size with locality, to be considered as forming "the exceptions" necessary to "prove the rule."

That there are such exceptions, among both birds and mammals, I have been long aware, and long since noticed that where there is an actual increase in size to the southward it occurs in species that belong to families or genera that are mainly developed within the tropics, there reaching their maximum development, both in respect to the number of their specific representatives and in respect to the size to which some of the species attain. This fact seems also to have been observed by others.[1]

Most of the mammals of North America belong to families, subfamilies, or genera which have their greatest development in the temperate or colder portions of the northern hemisphere, as the *Cervidæ*, the *Canidæ*, the *Mustelidæ*, the *Sciuridæ* (especially the subfamily *Arctomyinæ*), the *Leporidæ*, the *Castoridæ*, the *Arvicolinæ* among the *Muridæ*, the *Saccomyidæ*, *Geomyidæ*, etc. These rarely present an exception to the general law of decrease in size southward, though the variation is less (in fact, occasionally almost *nil*) in some species than in the others. The more marked exceptions, or those in which there is an actual increase in size southward, occur in those families that reach their highest development within the tropics, as the *Felidæ* and *Procyonidæ*.

In some species (as I have elsewhere noticed) there probably exists a double decadence in size, the individual reaching its maximum dimensions where the conditions of environment are most favorable for the existence of the species, and diminishing in size toward the northern (through scarcity of food and severity of climate) as well as toward the southern (in consequence of the enervating influence of tropical or semitropical conditions) limit of its distribution.

[1] I find that Mr. Robert Ridgway, some two years since, thus referred to this point. In alluding to the smaller size of Mexican specimens of *Catherpes Mexicanus* as compared with specimens from Colorado (*C. Mexicanus* var. *conspersus*), he says, "As we find this peculiarity exactly paralleled in the *Thryothorus ludovicianus* of the Atlantic States, may not these facts point out a law to the effect that in genera and species in the temperate zone the *increase in size with latitude is toward the region of the highest development of the group?*" (Baird, Brewer, and Ridgway's Birds of North America, vol. iii., App., p. 503, 1874.)

In a general way, the correlation of size with geographical distribution may be formulated in the following propositions: —

(1.) *The maximum physical development of the individual is attained where the conditions of environment are most favorable to the life of the species.* Species being primarily limited in their distribution by climatic conditions, their representatives living at or near either of their respective latitudinal boundaries are more or less unfavorably affected by the influences that finally limit the range of the species. These influences may be the direct effects of too high or too low a temperature, too little or too much humidity, or their indirect effects acting upon the plants or other sources of food. Hence the size of the individual generally correlates with the abundance or scarcity of food. Different species being constitutionally fitted for different climatic conditions, surroundings favorable to one may be very unfavorable to others, even of the same family or genus. Hence

(2.) *The largest species of a group* (genus, subfamily, or family, as the case may be) *are found where the group to which they severally belong reaches its highest development, or where it has what may be termed its centre of distribution.* In other words, species of a given group attain their maximum size where the conditions of existence for the group in question are the most favorable, just as the largest representatives of a species are found where the conditions are most favorable for the existence of the species.

(3.) *The most "typical" or most generalized representatives of a group are found also near its centre of distribution, outlying forms being generally more or less "aberrant" or specialized.* — J. A. Allen, Bulletin U. S. Geological Survey of the Territories.

A Gorilla in England. — Mr. Moore, Curator of the Free Public Museum at Liverpool, sends the following letter to *The London Times* of June 23d: —

"Sir, — A veritable young living gorilla was yesterday brought into Liverpool by the German African Society's Expedition, which arrived by the steamship Loanda, from the West Coast. The animal is a young male, in the most perfect health and condition, and measures nearly three feet in height. Its beetling brows, flattened, podgy nose, black muzzle, small ears, and thick fingers, cleft only to the second joint, distinguish it unmistakably from the chimpanzee. Only one other specimen has been brought alive to England. In the winter of 1855–56 a young female gorilla, of much smaller size, was exhibited by the late Mrs. Wombwell in Liverpool and other places. It died in March, 1856, and was sent to Mr. Waterton, of Walton Hall, who preserved the skin for his own collection, and sent the skeleton to the Leeds Museum. This specimen I saw living in Liverpool and dead at Walton Hall. All subsequent attempts to import the gorilla alive have failed; and, unfortunately, the British public will have no opportunity of profiting by the present suc-

cess, as the members of the expedition, with commendable patriotism, are taking the animal, on Saturday, *via* Hull to Berlin. Could it have graced our own Zoölogical Gardens it would have been the lion of the day; for, in addition to the great scientific interest of the species, the abounding life, energy, and joyous spirits of this example would have made it a universal favorite. Courteously received at Eberle's Alexandra Hotel by the members of the expedition, I found the creature romping and rolling in full liberty about the private drawing-room, now looking out of the window with all becoming gravity and sedateness as though interested, but not disconcerted, by the busy multitude and novelty without; then bounding rapidly along on knuckles and feet to examine and poke fun at some new-comer; playfully mumbling at his calves, pulling at his beard (a special delight), clinging to his arms, examining his hat (not at all to its improvement), curiously inquisitive as to his umbrella, and so on with visitor after visitor. If he becomes overexcited by the fun, a gentle box on the ear will bring him to order like a child, — like a child, only to be on the romp again immediately. He points with the index finger, claps with his hands, pouts out his tongue, feeds on a mixed diet, decidedly prefers roast meats to boiled, eats strawberries, as I saw, with delicate appreciativeness, is exquisitely clean and mannerly. The palms of his hands and feet are beautifully plump, soft, and black as jet. He has been eight months and a half in the possession of the expedition, has grown some six inches in that time, and is supposed to be between two and three years of age."

Egg of Chionis. — In the final article of Bulletin No. 3 of the National Museum, upon *Chionis minor*, by Dr. Coues and myself, appears (page 89) the following paragraph: —

"An egg of *C. minor* was received by the Zoölogical Society, January 17, 1871, concerning which Prof. Alfred Newton said, 'No egg of either species of this genus had before been known, and this confirms, by its appearance, the systematic position of the form shown by osteology, its affinity, namely, to the plovers.'"

Since on the preceding page there is cited from the *Ibis* a mention of a letter from Mr. Layard, dated at Cape Town in 1867, wherein an egg of this bird had been described, the impression is naturally conveyed that Professor Newton had overlooked this previous description. Such an impression was held by us at the time of writing, and a passing mention thereof was furthermore made by me in an article upon the same subject, which appeared in the *Popular Science Monthly* for March last.

I have since learned that Mr. Layard was misinformed with regard to the authenticity of his specimen, brought him by a whaling captain, and that it proved not to belong to Chionis at all.

A considerable injustice has therefore been unwittingly done Professor Newton, which I beg that you will allow me the opportunity for repairing by giving publicity to this note. — J. H. Kidder, Surgeon U. S. Navy.

ANTHROPOLOGY.

An African Potter at her Work. — I was much interested in one village (Kisunge) by watching a potter at her work. First she pounded enough earth and water for one pot, with a pestle such as they use in beating corn, till it formed a perfectly homogeneous mass. She then put it either on a flat stone or on the bottom of another, and giving it a dab with her fist in the middle to form a hollow, worked it into a shape roughly with her hands, keeping them constantly wet, and then smoothed out the finger-marks with a corncob, and finally polished it over with one or two bits of gourd and a bit of flat wood, the bit of gourd giving it the proper curves, and finally ornamenting it with a sharp-pointed stick. I went to look at it, wondering how it was to be taken off the stone and the bottom shaped, when lo and behold, it had no bottom ! I waited to see what would be done, and after it had been drying four or five hours in a shady place it was stiff enough to be handled carefully, and a bottom worked in of another piece of clay. I timed one from beginning to pound the clay till it was put aside to dry, and it took thirty-five minutes; putting in the bottom might take ten more. This pot would hold from two and a half to three gallons. The shapes of many are very graceful, and all are wonderfully truly formed (like the amphora in Villa Diomed at Pompeii) ; they are used for palm oil. — *Cameron's Diary, Journal of the Royal Geographical Society.*

GEOGRAPHY AND EXPLORATION.

Exploring Expeditions in Greenland. — In the summer of 1875, Mr. Helland, a Norwegian geologist, visited Greenland and made some exact and consequently very important observations on the rate of movement of the interior ice. His measurements were made at the great Jacobshavn glacier and also at the Itifdliarsuk glacier, at the opening of the Tossukuset Fiord, whence the great harvest of icebergs sweeps down the Waigat.

In April, 1876, Mr. Steenstrup, the eminent geologist, and Lieutenant Holm, a young and enterprising officer of the Royal Danish Navy, sailed for Greenland, according to the *Geographical Magazine*, with the intention of penetrating into the interior. The first attempt will probably be made from the Tunnudliarbik Fiord, near Julianehaab, in the hope of being able to reach a mountain-peak which has been observed in the far distance to pierce the surface of the glacier, and is known as the " Jomfruerne " or " Niviarsiæt." But this will only be preliminary, and the gallant explorers intend to renew their attempts for three or four years, until they succeed. The Danish government has granted the necessary funds for this noble enterprise.

Those interested in arctic research will be glad to hear that Dr. Rink's famous work on Greenland is to be translated into English. This is the most authoritative work on that country, Dr. Rink having

been for years Director of Greenland. It will be in one volume, and, besides giving a general history of Greenland and its people, will contain an appendix relating to the natural history and meteorology of the country, and will be illustrated by a series of plates (fac-similes of drawings by the Greenland Eskimo, some of which have already found their way into the United States) and a new map.

It appears that the great harvest of white bear-skins is obtained in Greenland from the extreme south, when the bears come on the ice drifted around Cape Farewell in the current from the east coast; that some are taken on the ice round Upernavik in the far north, but that bears are very scarce between Julianehaab and Upernavik. The cod-fish are mainly taken on the Torske Bank, off Sukkertoppen, and the narwhal horns are entirely from North Greenland.

MICROSCOPY.[1]

Microscopy at the American Association. — The subsection of microscopy of the American Association for the Advancement of Science, which has hitherto been a transient organization, temporarily formed whenever necessary, was established as a permanent body at the Buffalo meeting in August last. In addition to business connected with the details of organization, nine papers were read, and many interesting discussions were held. Two evenings were occupied, one by an informal *soirée* at the rooms of the subsection, and the other by a very successful reception tendered by the Buffalo Microscopical Club. The members present were cordially and unanimously in favor of the permanent organization. Dr. R. H. Ward, of Troy, was elected chairman for the first year, ending with the Nashville meeting next August. It is earnestly desired and hoped that the microscopists of the country will take such an active interest in the organization as to secure for themselves and others the really great advantages which it offers.

Double-Stained Muscular Fibres. — Dr. Geo. D. Beatty calls attention to the *Lissotriton punctatus* (the smooth-skin newt) and the *Amphiuma tridactylum* as microscopical treasures, the muscular fibres, especially of the tongue, being particularly beautiful, the transverse striæ being very well marked, and the nuclei very large in both species, and greatly elongated in *Amphiuma*, stretching one third across the field with a one-fifth objective and A ocular. The tissues should be double, stained for the nuclei with carmine and with picric acid to bring out the transverse striæ. The tissue is hardened by ninety-five per cent. alcohol, followed by absolute alcohol, and sections cut in a section machine or fibres teased out carefully with needles. The sections or threads are placed for one minute in twenty-five per cent. alcohol, soaked for five minutes in Dr. J. J. Woodward's borax-carmine solution, soaked about ten minutes in alcohol acidulated with twenty per cent. of hydro-

[1] Conducted by Dr. R. H. Ward, Troy, N. Y.

chloric acid until the carmine is nearly removed from all parts except the nuclei, washed in alcohol for a few minutes, the solution being changed until free from acid; then placed for one half to one minute in an alcoholic solution, one twelfth grain to one ounce of picric acid, washed in alcohol, and transferred through absolute alcohol and oil of cloves to balsam for mounting.

PHOTO-MICROGRAPHY. — Dr. Charles Jewett, of Brooklyn, N. Y., has produced extremely perfect photographs of *Amphipleura pellucida* with Tolles's one-fifth immersion objective, B ocular, and Zentmayer's amplifier.

A NEW FUNGUS. — Mr. J. P. Moore has presented to the San Francisco Microscopical Society a specimen and description of a remarkable fungus found growing from a beam in an abandoned drift, four hundred feet below the surface, in the Yellow Jacket Mine, Gold Hill, Nevada. The growth commences as a pure white mycelium bursting out of the wood. The specimen described was three feet four inches long, of a light buff color, and consisted mainly of a three-parted stem, two or three inches in diameter, attached by means of a disk eight or ten inches wide. Towards the other end the stem divided into short branches greatly resembling in shape and arrangement the young antlers of a stag, the three terminal ones being much the most vigorous and conspicuous, forming a perfect trident. The gills are distant, decurrent, notched, and sinuate, and of a pale straw color; the spores ovate or round, exceedingly minute, and borne on true basidia. The plant is called by the miners the lily of the mines; by Mr. Moore, *Agaricus tridens.*

SCIENTIFIC NEWS.

— The Bulletin of the United States Geological and Geographical Survey of the Territories, Vol. ii., No. 4, issued August 4, 1876, contains the following papers: Notes on the Geology of Northeastern New Mexico, by O. St. John. Sexual, Individual, and Geographical Variation in *Leucosticte tephrocotis*, by J. A. Allen. Geographical Variation among North American Mammals, especially in Respect to Size, by J. A. Allen. Descriptions and Illustrations of Fossils from Vancouver's and Sucia Islands and other Northwestern Localities, by F. B. Meek. Note on the new Genus Mintacrinus, by F. B. Meek.

— Advices from Professor Hayden, in charge of the United States Geological Survey of the Territories, state that his parties are all in the field and with orders to finish the work in Colorado and return by November 1st. Professor Hayden has been with one of the parties making an examination of Raton Mountains and San Luis Park so as to perfect the coloring of the geological map.

PROCEEDINGS OF SOCIETIES.

ACADEMY OF NATURAL SCIENCES, Philadelphia. — June 27th. The meeting was attended by Dom Pedro II., Emperor of Brazil, and his minister plenipotentiary, Senhor A. P. Carvalho de Borges.

Dr. Leidy made a communication upon the structure and life of the Rhizopods. The formation of the shells of the Difflugians was described, and a number of forms were figured.

Professor Cope called attention to certain mammalian remains from the neighborhood of Santa Fé. The specimens exhibited belonged to the *Mastodon productus*, which must have been very abundant in that region. The speaker dwelt upon the peculiarities which distinguished it from *Mastodon Ohioticus*, and gave at length the characters of the dentition.

The three prominent types of mammals from the Eocene, Miocene, and Upper Miocene formations of the West weredescribed and illustrated by fine specimens of skulls of *Loxolophodon cornutus*, *Symborodon acer*, and *S. altirostris*.

Professor Frazer described a collection of microscopic sections of igneous rocks, the peculiarities of which were exhibited by means of the screen and lantern. Certain Brazilian Dolerites were contrasted with others from York County, Pa.

Dr. Horn placed on record a method of distinguishing sexes in the genus *Amblycheila*, depending upon the shape of the trochanters.

July 11th. Mr. Gabb called attention to the use of borax as a substitute for alcohol in the preservation of animal tissues.

July 18th. Mr. Meehan exhibited specimens of *Senecio Jacobæa*, a hardy herbaceous plant which had recently flowered for the first time in fifteen years. He also gave the results of his observations on the mode of fertilization of Campanula, which he believed to be entirely independent of insect agency. The mode of fertilization of the dandelion and chiccory was also described and illustrated. Both of these plants were considered self-fertilizers.

Professor Cope spoke of the species of fossil dogs found in the Santa Fé marl. The vertebrates found in that formation now number thirty-two, including eleven species of Canis. These are all extinct, with the exception of one species of wolf, the *Canis cævis* of Leidy. This was believed to be identical with the living wolf, which was considered to be specifically identical with the common dog. The species mentioned originated in the Upper Miocene and persists to the present day. A new form was described under the name of *Canis Wheelerianus*. The relative size and other characters of the species heretofore described were given.

The number of species of fossil deer found in the formation spoken of was increased from four to six, the two new forms being named

Dicrocerus trilateralis and *Dicrocerus tehuanus.* In answer to Dr. McQuillen, Professor Cope stated that he had at one time supposed that the burrs on certain of the antlers of the fossil deer indicated the seat of fractures, but he had not in all cases been able to find evidence supporting this view. The fact was also pointed out that these antlers had a superficial coating or epidermis which would be sufficient to hold the fractured pieces in place.

Academy of Sciences, St. Louis. — May 15th. Judge Holmes remarked as follows upon man and the elephant in Nebraska. In Dr. Hayden's Annual Report of the United States Geological Survey for the year 1874, recently published, appears the report of Dr. Samuel Aughey on the Loess deposits of Nebraska. It is stated that the Loess covers three fourths of the surface of that State, ranging in thickness from forty to one hundred and fifty feet, and extending westward from the Missouri River to a limit beyond Kearney and the Republican Fork.

The more important fact which he desired to notice was that Dr. Aughey, after some years of careful searching, had succeeded in finding imbedded in this deposit two distinctly-shaped and well-worked arrow-heads, which are figured in his report (page 255). One of them, a small arrow-head, was found at a depth of fifteen feet, at a place three miles east of Sioux City; the other, nearly four times larger, might very well have been a spear-head, and it was found at a place two and a half miles southeast of Omaha, and at a depth of twenty feet, and "thirteen inches above the point where it was found, and within three inches of being on a line with it, in undisturbed Loess, there was a lumbar vertebra of an elephant (*Elephus Americanus*)." The material is not named nor are measurements given. Flint chips are mentioned as found "in the bluffs" in Dakota County, but as not certainly of human origin.

The discovery is important as going to show the contemporaneity of man and the elephant on this continent during the period of the Loess. They must have inhabited together the shores of the great inland seas or expansions of the rivers, in which the Loess formation was deposited. It furnished the first distinct and incontrovertible proof of this fact that he was aware of. Bones of mastodon, elephant, and other extinct animals had been frequently found in the Loess of the Mississippi Valley, but hitherto no human remains had been ascertained with certainty to belong to it. Mr. Worthen, of the Illinois Geological Survey, had reported an instance of arrow-heads being found together with bones of extinct mammalia in an altered drift covered by Loess near Alton; but the circumstances, geologically considered, seemed to admit of some doubt on the question of their cotemporaneousness. But here no room would seem to be left for any other rational hypothesis. Both the arrow-head and the vertebra must have been deposited in the still waters of the lake, or been drifted to the spot by the same moving waters of the Loess period. The arrow-head, certainly, could not have

got there if it had belonged to a more recent period. But it is still possible that the vertebra may have been washed out of some older deposit by the action of rivers, and been swept down into the lake; or it may have been frozen into a mass of ice and been carried down by the river, and dropped to the bottom on the melting of the ice. The presence of mastodon bones with the arrow-head, in the Benton County case, has been accounted for in this way: The presence of the arrow-head proved the existence of man in the alluvial period only; but in this instance the arrow-head must have been contemporary with the older Loess deposit, and the bones of mastodon, elephant, and other extinct species of mammalia are so abundant in this deposit, not only in Nebraska but throughout the Mississippi Valley, that no doubt can remain that these animals were also contemporary with the Loess.

In the instances reported by the late Dr. Koch (Tranactions of the St. Louis Academy of Science, i. 61 and 117), of arrow-heads found together with the bones of mastodon, one in the alluvial bottom of the Pomme des Terres River in Benton County, Mo., and the other in the bottom land of the Bourbeuse River, in Gasconade County, Mo., it was possible to explain the facts stated by him as being the result of more recent changes in the local alluvial drift of the river channel. Dr. Wizlizenus (Ibid., page 168) endeavored to account for all the phenomena in this way, and in the latter case by supposing that Indian fires had been built over the spot at a time long subsequent to the deposit of the bones, and the whole afterwards covered by alluvial overflows. He was well acquainted with Dr. Koch, and did not question the veracity of his statements. Judge Holmes had himself assisted Dr. Koch in putting his article into shape for publication in the Transactions, and questioned him minutely as to the particulars stated, and could certify that the circumstances mentioned were positively asserted by him to be true. Nor had he any reason for doubting the truthfulness of Dr. Koch. As lately suggested by Professor J. D. Dana, it is true that Dr. Koch was not a thoroughly scientific and practical geologist, and perhaps he gave some scope to his imagination in the matter of theorizing upon his facts; but he had some experience in such things, and might be allowed to be capable of observing the facts which he stated, however incompetent to apply the requisite tests for a certain conclusion. But the facts observed and reported were not absolutely conclusive of the matter, though carrying much weight of probability.

In this new discovery in Nebraska we have facts well ascertained by a competent observer; they are not open to the same kind of explanation; and they seem to afford the necessary confirmation of the supposed contemporaneity of man and the mastodon and elephant in this valley.

Dr. George Engelmann gave some results of his observations on the venation of American oaks. He has observed great differences in the venation of different species, some having folded or conduplicate, and

others revolute foldings, and still others are concave and imbricated. But the venation does not seem to furnish characters distinguishing between the two principal sections, the white and black oaks.

June 5th. Dr. George Engelmann read a communication on certain fungi of the grape and oak.

Professor Riley exhibited specimens of the periodical Cicada, in the pupa and perfect states, recently received from Mr. Charles McCorkle, of Lexington, Va. Eight years ago Professor Riley had shown that there were thirteen as well as seventeen year races of this periodical Cicada, and in a chronological history of the species he had at that time predicted that "in the year 1876, and at intervals of seventeen years thereafter, they will in all probability appear from Raleigh, North Carolina, to near Petersburg, Virginia; in Rowan, Davie, Cabarras, and Iredell counties in North Carolina; in the valley of Virginia as far as the Blue Ridge on the east, the Potomac River on the north, the Tennessee and North Carolina lines on the south, and for several counties west; in the south part of St. Mary's County, Maryland, dividing the county about midway east and west; in Illinois about Alton; and in Sullivan and Knox counties, Indiana."

The specimens from Mr. McCorkle were proof of the correctness of the prediction in regard to Virginia. While this insect requires thirteen or seventeen years, according to the race, for its underground development, the actual development has never been watched from the egg to the mature insect. In 1868 he had collected together in a particular spot near this city a large number of the hatching eggs of a thirteen-year brood which will appear here again in 1881, and he had been able to obtain and note the development of the larvæ every year since. They are now about two thirds grown.

He also exhibited cocoons and spinning worms of the common mulberry silk-worm (*Sericaria mori*) reared on Osage orange. The worms were a cross between the best French and Japanese races, and he had reared them for five years on Osage orange with no reduction in quantity or quality of silk, and great increase of vigor and healthfulness. There is no reason why our ladies might not be dressed with silk from our own native hedges.

June 19th. Professor Riley exhibited specimens of a worm that was just at this time devastating the wheat fields of parts of Kansas, and particularly of Dickinson County. It does not eat the blades but attacks the heads. Professor Riley had determined the species to be *Leucania albilinea*, though the insect had never before been reported as injurious from the West. The species is generically allied to the common army worm, and may be popularly called the wheat-head caterpillar. As it had never till lately attracted unusual attention, too little was yet known of its habits to warrant any suggestion as to the best mode of destroying it.

Professor Riley also exhibited a specimen of *Doryphora decemlineata*, that was so completely covered with a mite parasite belonging to the *Gamasidæ*, and apparently the *Gamasus coleopteratorum* L., that the point of a needle could not be placed on any part of the beetle's body without touching one of the parasites. He estimated that there were over eight hundred of the mites, and they had killed their victim. Aside from the toad and other reptiles, the crow, rose-breasted grosbeak, and domestic fowls among birds, which prey on the potato pest, he had, in his reports, figured or described no less than twenty-three insect enemies that attack and kill it. Only one of these is a true parasite, and the mite exhibited made the second, or just two dozen insect enemies in all.

He mentioned the fact in this connection that the *Doryphora* had reached New Hampshire, and was doing great injury along the Atlantic coast.

The American Association for the Advancement of Science held its twenty-fifth meeting at Buffalo, commencing August 23d and closing August 30th. In point of numbers, the variety and quality of papers read, and the harmony of its sessions, it was quite equal to any of its predecessors; while the warm hospitality with which the association was greeted by the citizens of Buffalo added a social charm peculiarly its own. The success of the meeting was largely due to the untiring endeavors of the local committee, and especially of Mr. Grote and Captain Dorr, and it is to be hoped that the Society of Natural Sciences, the initiator of the movement which brought the association to Buffalo, and the leader in its entertainment, may reap the reward that is its due in the higher esteem in which it will be held at home — the esteem it already has among kindred associations in the country.

The president, Prof. Wm. B. Rogers, guided the deliberations of the general session with marked grace and dignity, and, in his responses to the hospitalities proffered the association, his welcome to the foreign guests, and his parting words, showed that the wonderful felicity of diction, not to say eloquence, for which he was noted has not been dimmed by his long illness. This being "Centennial year," no less than sixteen foreign scientists of greater or less distinction were present, a number far exceeding that of any former meeting of the association; most of them were chemists and physicists, but among those in whom the readers of the Naturalist are more generally interested were Professor Huxley, of England, and Drs. Torell, Lindahl, and Nordström, of Sweden. Drs. Torell and Lindahl indeed read papers before the Natural History Section, the former on the sources of the ancient glaciers of North America, the latter on the structure of the tongue in *Picus viridis*. Professor Huxley also spoke in general session of his impressions of America, in response to his welcome by President Rogers, and in Section B briefly discussed one of Dr. Wilder's papers on the brains of the lower vertebrates. A few papers were also read in the physical section

by others of the foreign guests. All this gave a certain interest to the meeting which is not likely to be surpassed in kind for many a year.

Two of the permanent committees offered extended reports: one on weights, measures, and coinage, the outcome of which was a series of resolutions passed unanimously, deprecating any revival of the double standard of value in this country; the other on zoölogical nomenclature, where the committee reported an irreconcilable difference of view on certain points and propounded a series of inquiries for discussion at a future meeting. This report was referred to Section B, which appointed a special committee to print and distribute the report, with a view of obtaining the written opinion of naturalists at large upon the questions involved.

The association took the initiative in proposing an international congress of geologists at Paris in 1878, "for the purpose of getting together comparative collections, maps, and sections, and for the settling of many obscure points relating to geological classification and nomenclature." The committee appointed to attend to the matter consists of Professors Rogers, Hall, Hitchcock, and Pumpelly, and Drs. Dawson, Newberry, and Hunt; and Drs. Torell and von Baumhauer and Professor Huxley were added to represent the purpose of the association in Europe.

Two hundred and five members and fellows entered their names upon the register, and one hundred and forty-two new members were elected; seventeen fellows were added, among them Dr. E. B. Andrews, Mr. L. S. Burbank, Dr. E. Coues, Dr. C. Rau, and Prof. Daniel Wilson, of the Natural History Section.

All of the addresses were able and were listened to with marked attention. Ex-President Hilgard spoke of the History and Progress of Geodetic Science; Vice-President Young of Section A treated of his own department of Solar Physics; Chairman Barker of the chemical subsection explained the modern scientific ideas concerning the atom and the molecule. Mr. Morgan disappointed those of the anthropological subsection who had looked to their chairman for an address, but he certainly made up for the omission by the number and value of papers on the Iroquois with which he afterwards favored them; indeed, the new subsection of anthropology was in general remarkably well sustained. Vice-President Morse of Section B gave a most valuable and extended critical review of what American students have done for the doctrine of evolution, the only fault to be found with which was that it needed a supplementary notice by another to show what the speaker himself had done. It would almost seem as if this address had given the key-note to the sessions of the section, for comparatively few papers were presented which did not at least show with how powerful an influence the doctrine of evolution had possessed the thoughts of the speaker; and, as remarked by Professor Morse on closing the sessions, so far were evolutionary views from eliciting a storm of dispute, as would have been

the case ten years ago, that exception had been taken to scarcely a single point. Unquestionably the most remarkable paper presented before this section was that by Dr. W. K. Brooks, of Boston, on proposed modifications in Darwin's theory of pangenesis, but space will not here permit a fair abstract; simpler even than that proposed by Darwin, it explained many points which were not met by the latter. One hundred and seventy-four papers were presented to the standing committee, of which all but about a dozen were read in full or by title; and these were almost equally divided between the physical and natural history sections.

The association was invited to meet at Nashville, Atlanta, and St. Louis; the first place was chosen, and August 29, 1877, selected as the opening day; the following are the officers elect: President, Professor Simon Newcomb, of Washington; Vice-Presidents: Section A, Professor E. C. Pickering, of Boston; Section B, Professor O. C. Marsh, of New Haven; Permanent Secretary, F. W. Putnam, of Salem; General Secretary, A. R. Grote, of Buffalo; Secretary Section A, Dr. H. C. Bolton, of New York; Section B, Lieutenant W. H. Dall, of Washington; Treasurer, W. S. Vaux, of Philadelphia; Chairman Subsection of Chemistry, Professor N. T. Lupton, of Nashville; Subsection of Microscopy, Dr. R. H. Ward, of Troy; Subsection of Anthropology, Professor Daniel Wilson, of Toronto.

The following papers were read in the order here given, under their respective subsections.

GEOLOGY AND NATURAL HISTORY.

W. H. Dall, On the Mode of Extrusion of the Ova in the Limpets. Burt G. Wilder, Notes on the North American Ganoids: (*a*) the Supposed Transformation of the Tail of *Amia;* (*b*) the Serrated Appendages of the Hyoid Isthmus of *Amia.* Warren Upham, On the Origin of Kames or Eskers in New Hampshire. Joshua Lindahl, Some new Points regarding the Tongue of *Picus viridis.* T. Sterry Hunt, On the Geology of Eastern Pennsylvania. James Hall, Note upon the Geological Position of the Serpentine Limestone of Northern New York, and an Inquiry regarding the Relations of this Limestone to the Eozoön Limestone of Canada. L. Elsberg, On the Plastidule Hypothesis. T. Meehan, On Self-Fertilization and Cross-Fertilization in Flowers. A. R. Grote and W. H. Pitt, The Water Lime Group of Buffalo. T. Meehan, On Graft Hybrids. W. K. Brooks, On the Provisional Hypothesis of Pangenesis. Albert H. Tuttle, On a new Species of Argulus. Burt G. Wilder, Notes on the Brains of the Fish-Like Vertebrates: (*a*) Myxinoids; (*b*) Sharks and Skates; (*c*) Chimera; (*d*) Teleosts. F. A. Gooch, A Note upon the Pitchstones of Arran. Fred. W. Simonds, On *Sycotypus* (*Busycon*) *canaliculatus* Linn. J. S. Newberry, The Relations of the Rocks of Ohio to those of Pennsylvania and New York.

J. S. Newberry, The Origin and Mode of Formation of the Great Lakes. O. C. Marsh, Principal Characters of American Peterodactyles. S. W. Garman, On a Variation in the Colors of Animals. Samuel H. Scudder, A Brief Comparison of the Butterfly Faunas of Europe and Eastern North America, with Hints concerning the Derivation of the Latter. W. H. Dall, On the Reciprocal Relations of certain Genera of Articulated Brachiopods. J. W. Dawson, New Facts relating to *Eozoön Canadense*. A. Winchell, On the Siphon of Endoceras, a Genus of Chambered Shells. J. Muir, On the Post-Glacial History of *Sequoia gigantea*. Burt G. Wilder, The Slight Morphological Value of Natural Attitude and Numerical Composition. Albert H. Tuttle, Notes on the Myriapods of Ohio. Wm. H. Seaman, Description of new Fungus on the Leaves of the Pear-Tree. P. R. Uhler, The Edible Crab of Maryland, *Callinectes hastatus* (Ordway). W. J. Beal, Phyllotaxis of Cones. W. J. Beal, Can the Unios see? W. J. Beal, Cross-Fertilization of Apple Blossoms W. J. Beal, Sensitive Stigmas as an Aid to Cross-Fertilization of Flowers. C. V. Riley, Biological Notes on the Army Worm (*Leucania unipuncta* Haw.). A. R. Grote, A Preliminary Note on *Menopoma Alleghaniensis* of Harlan.

ANTHROPOLOGY.

H. Gillman, Peculiarities of the Femora from Tumuli in Michigan. O. T. Mason, The Scope of Anthropology, and the Classification of its Materials. L. H. Morgan, The Iroquois Gens. H. Gillman, Some Observations on the Orbits of the Crania from Mounds. O. T. Mason, Archæological Collections from Porto Rico. Alessandro Castellani, Etruscan and Greek Art in Jewelry, and its Revival. Daniel Wilson, Hybridity and Absorption among the Races of the New World. J. W. Powell, On the Mythology of the North American Indians. L. H. Morgan, The Iroquois Phratry. D. Wilson, Brain-Weight and Size in Relation to the Relative Capacity of Races. G. H. Perkins, On some Fragments of Pottery from Vermont. O. T. Mason, The International Symbols for Charts of Prehistoric Archæology. L. H. Morgan, The Iroquois Confederacy. H. Gillman, Investigation of the Burial Mound at Fort Wayne on the Detroit River, Michigan. E. A. Barber, On the Ancient and Modern Pueblo Tribes of the Pacific Slope of the United States. Isaac B. Choate, The Mood of the Verb in Conditional Clauses. Heinrich Frauberger, The Museums of Industrial Art in Austria. S. D. Peet, The Archæology of Europe and America compared. S. D. Peet, On the State of Society in the Primitive Age.

MICROSCOPY.

E. W. Morley, Results of Measurements of Eleven of Möller's *Diatomaceen Probe-Platten*. E. W. Morley, Micrometric Measurements of Rulings on Glass by Mr. Rogers. E. W. Morley, Micrometric Measurements of Rulings on Glass by Mr. Rutherfurd. W. H. Bullock, Simple

Means of adapting the Binocular Microscope to Defects in the Eye. R. H. Ward, Remarks on some American Contributions to the Development of the Modern Microscope. P. H. Van der Weyde, On a new System of Finder for the Microscope. P. H. Van der Weyde, On a few Simplifications of the Polarizing and of the Spectroscopic Microscope. P. H. Van der Weyde, On some Modifications and Special Attachments to the Microscope for Chemical Research. George Beatty, Results obtained by Double Staining of Muscular Tissue of Amphiuma with Picric Acid and Carmine.

SCIENTIFIC SERIALS.[1]

THE GEOLOGICAL MAGAZINE. — August. Contributions to the Study of Volcanoes, by J. W. Judd. Pebble Ridges, by T. M. Reade. Remarks on Mr. Burns's Paper on the Mechanics of Glaciers, by James Croll.

MONTHLY MICROSCOPICAL JOURNAL. — August. Observations upon Spermatozoa of *Amphiuma tridactylum*, by C. Johnston. On the Ossification Process in Birds, and the New Formation of Red Blood-Corpuscles during the Ossification Process, by Dr. L. Schöney. On a Possible Explanation of the Method employed by Nobert in ruling his Test-Plates, by W. A. Rogers.

THE GEOGRAPHICAL MAGAZINE. — August. Sketches of Life in Greenland. The Basin of the Ob and Yenisei Rivers. The Seat of War. Dr. Beccari's Third Visit to New Guinea, by H. H. Griglioni. The Sea-Level, by H. P. Malet.

ANNALES DES SCIENCES NATURELLES. — June 30th. Mémoire sur les Mœurs et l'Accouchement de l'*Alytes obstetricans*, par A. De L'Isle. Mémoire sur l'Embryologie de quelques Éponges de la Manche, par Ch. Barrois.

ERRATA.

IN the article on Progress of Ornithology in the United States, etc., published in the September number, the following corrections should be made: —

Page 540, 13th line from top, dele "and has recently been republished."

Page 541, add to the last line of the first paragraph, "and fifty prepared especially for this edition."

Page 544, 17th line from top, for "Lawrence and Fowler" read "Lawrence, Gregg, and Fowler."

Page 544, 16th line from bottom, for "Hoy and Barry" read "Pratten, Hoy, and Barry."

Page 545, 15th line from bottom, for "*Tringaœ*" read "*Tringeœ*."

Page 545, 9th line from bottom, for "myology" read "osteology."

Page 546, 11th line from bottom, for "Rogers and Wilkes" read "Perry and Wilkes, and Lieutenant Gilliss."

Also, in the article entitled Microscopes at the Loan Collection of Scientific Apparatus at the South Kensington Museum, the author's name should be "John Michels," instead of "John Nichols."

[1] The articles enumerated under this head will be for the most part selected.